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METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS

VOL 94 No 21 ONE SHILLING

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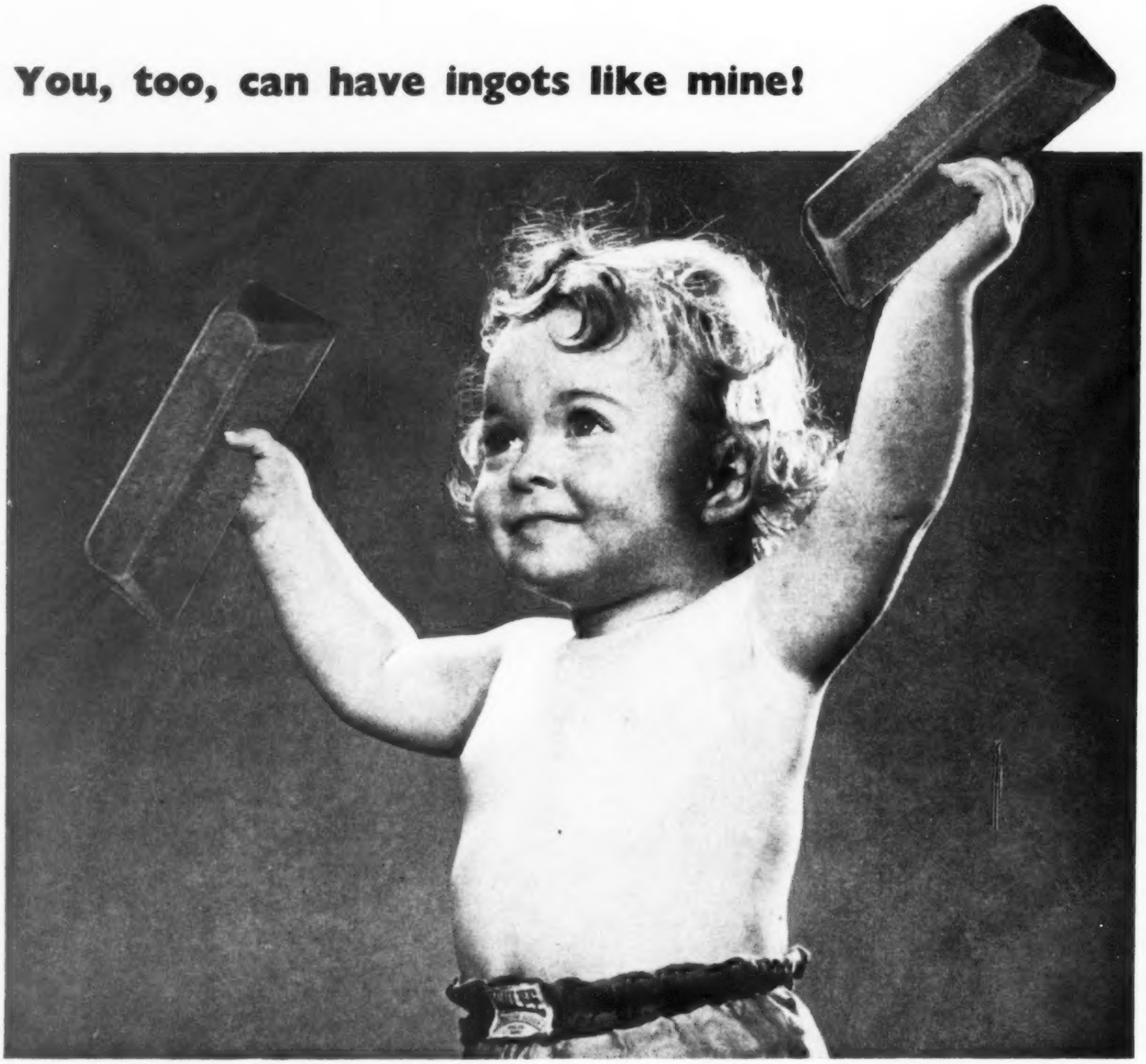

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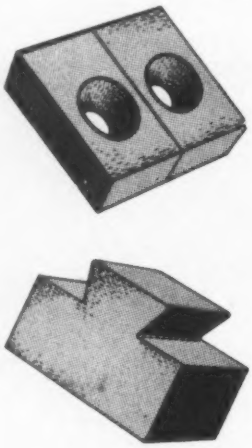

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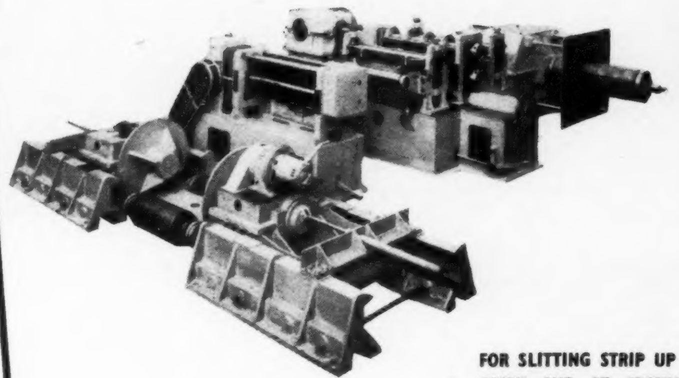

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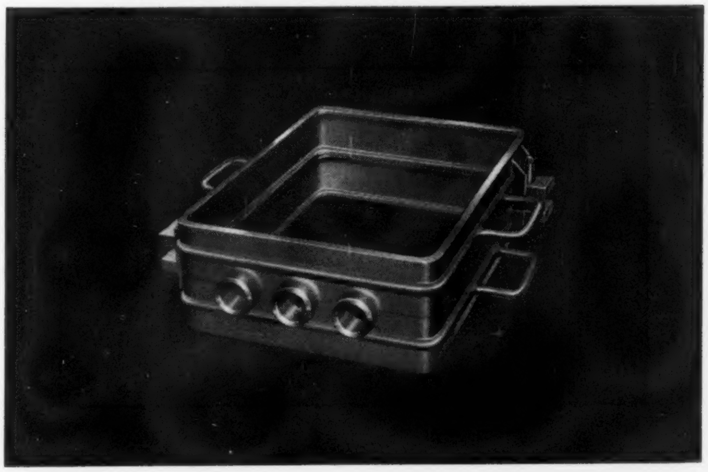

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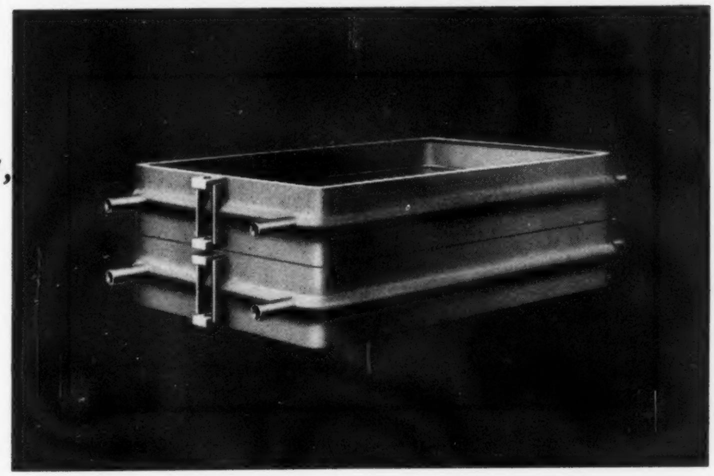

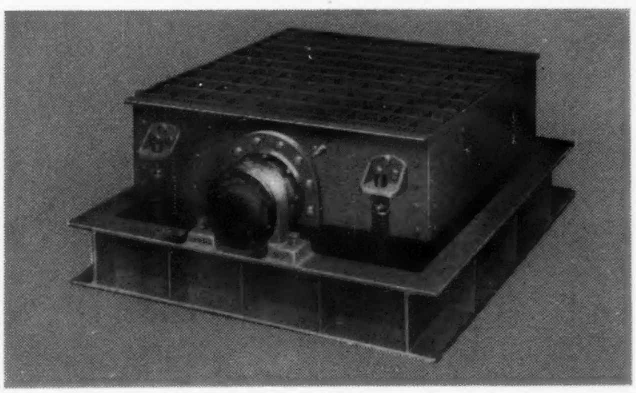

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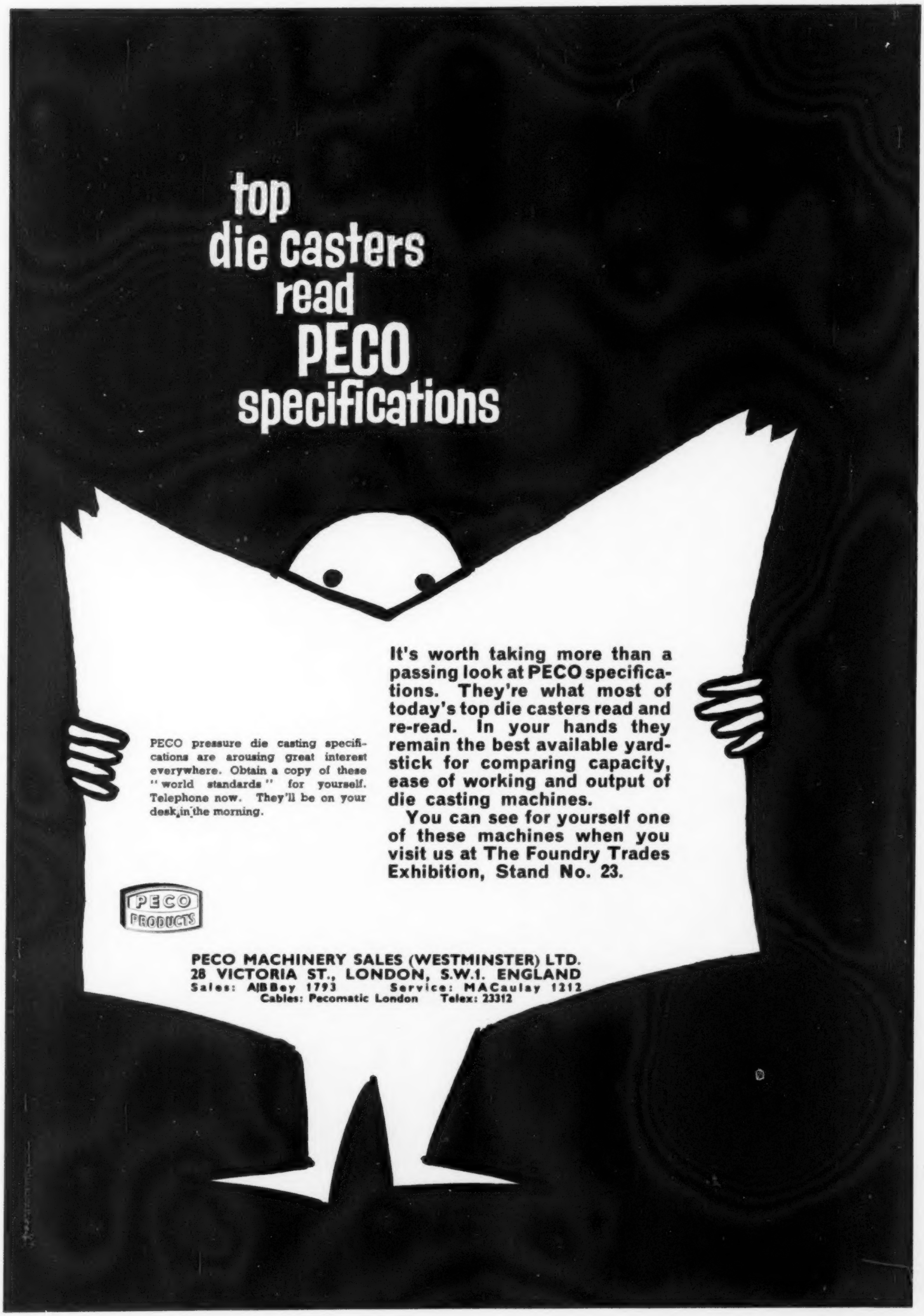
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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

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CONTENTS

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METAL INDUSTRY

VOLUME 94 NUMBER 21 22 MAY 1959

Quality Castings

TO-DAY, more than ever before, the foundry industry is faced with the necessity of reducing costs and at the same time maintaining the high quality of its products. It is, therefore, essential for the foundryman to keep abreast of developments and to make full use of all the sources of information available to him. In this issue of METAL INDUSTRY, devoted to the interests of founders of non-ferrous metals, the emphasis is laid on the production of quality castings because we firmly believe that it is only by a continued improvement in quality of output that the foundry industry can meet, and beat, the ever-growing competition from other materials and other forms of fabrication.

We would draw particular attention to the article by Mr. Frank Hudson on page 417. In it, the author, well-known in the foundry industry, makes a plea for the "hall marking" of copper alloy castings to ensure that the right standard of quality is being maintained. Already adopted in France by the light alloy and iron founders, the "quality label" is an index of the capacity of a particular industrial concern to produce a product according to an approved mode of manufacture and acceptable standard of inspection. Since a somewhat similar scheme is in operation in this country for zinc die-casters, whereby approved firms can use the "kite mark" of the British Standards Association, it should be an easy matter for other founders to follow suit. By the production of castings of guaranteed quality, there can be no doubt that goodwill will be strengthened and the volume of business increased.

Lest it be thought that the production of quality castings is beyond the scope of the smaller foundries, the article by Mr. A. B. Martin deals especially with their problems in regard to light alloys, and in a later instalment gives details of methods of checking that the desired results have been achieved; methods that do not require laboratory apparatus and only a very minimum of preparation. In the third article, modern methods of melting non-ferrous metals, essential to the production of quality castings, are considered.

Also in this issue will be found an account of those exhibits of direct interest to the non-ferrous founder that are to be seen at the foundry exhibition at Bingley Hall, Birmingham, which opened yesterday and is to continue till May 30. Promoted by the Foundry Trades' Equipment and Supplies Association, an organization representing the leading firms in the United Kingdom engaged in supplying the needs of founders, this is the first exhibition since the war devoted entirely to the interests of the foundry industry. Exhibitions of this nature encourage discussion and good relations between manufacturer, supplier and user. Only by such close co-operation can progress in design, operating techniques and the use of materials be maintained and stimulated. The effort is worthy of every support and we are confident that it will be a great success. Our only criticism is that we feel that success would have been even more assured if it had been possible to hold a convention at the same time as the exhibition. This system has proved to be well worth while at other exhibitions, notably the Mechanical Handling and Plastics exhibitions, and we commend the suggestion to the organizers and to the Institute of British Foundrymen, whose co-operation would, of course, be essential. Might it not be possible, for instance, to hold the exhibition at the same time and the same venue as the annual convention of the Institute of British Foundrymen?

Out of the MELTING POT

Another "Wax"

WHAT is still known as the lost wax casting process has nowadays, of course, at least in its industrial versions, more often than not nothing to do with the material provided by busy little bees. Here, as elsewhere, synthetics have largely replaced the natural product. Various thermosetting plastics, various low melting-point substances, mercury, plastics materials that can be dissolved out using organic solvents, and other "waxes" have been suggested for the purpose. Yet another suggestion envisages the use for such lost wax patterns of mixtures of urea with salts, for example, urea with 10 to 30 per cent potassium nitrate and sodium nitrate, or with 5 to 15 per cent of aluminium sulphate and ammonium sulphate. The above mixtures comprise both eutectic and hypoeutectic compositions with a relatively wide solidification temperature range which enables the production of patterns by injection moulding as well as by the simple casting technique. The mixtures have adequate fluidity and good mould filling ability. The patterns obtained using these mixtures do not take up moisture when exposed to the atmosphere and have good mechanical properties. The shrinkage is less than 0·15 per cent. The mixtures are readily soluble in hot water, and this enables the patterns to be removed with little trouble after the refractory investment has been applied. Another important advantage of these compositions is that in the process of removing the pattern by dissolving it in hot water, no thermal expansion of the pattern occurs and, consequently, no precautions against the risk of such expansion affecting the investment mould need be taken.

Framework for Thought

WHAT are the ways and means used in arriving at subjects for Symposia, conferences, and the like? Whether a given subject has been thought up on the spur of the moment by an individual, whether it has been selected from some list of possible subjects, whether it has emerged in the course of the deliberations of a committee or even a "brain-storming" team, is of less immediate interest than the nature of the best of such subjects and their peculiar fitness for the purpose for which they are intended. The above musings were set off by a particularly excellent example of the species: the subject chosen for discussion at this year's autumn meeting of the Société Française de Métallurgie, namely, "Gases in Metals." Probably the most important characteristic of this subject, as of all subjects of successful Symposia, is its ability to prompt the immediate reaction: but surely we know all about gases in metals. The success of the Symposium depends, of course, on the fact that even if we do know everything about gases in metals, it is some little time since we have known it, as a result of which we may well have forgotten some of it. There is also the fact that what knowledge there is, is scattered, and an opportunity of collecting it together will be most welcome. This will also serve one of the other main purposes of a Symposium, the provision of a setting in which any lack of knowledge is most likely to show up and in which it will be most readily observable. Yet another purpose is, of course, the provision of opportunities for personal contacts and communications which achieve more, and in a much shorter time, than could ever be achieved through the "literature." Considering all the benefits derived from a Symposium on a well-chosen subject, the question naturally arises as to whether more could not be done by way of thinking up more of such subjects. Not in order to have more Symposia (heaven forbid!) but in order to have more frequently the salutary experience, after making the necessary effort, of being able to have a look at the wood in spite of the trees.

Unexpected

SWEEPING statements always run the risk of sooner or later being proved to be wrong. Take, for example, the following recent remarks on the effect of common impurities in commercially pure titanium: "Oxygen, nitrogen and hydrogen are impurities in all titanium products. The first two are desirable when controlled within specified limits; this is accomplished by blending different grades of sponge. Hydrogen is always undesirable." Many a discovery has been made after first refusing to accept too categorical a statement. This has now happened in connection with the above statement regarding the effect of hydrogen in titanium. This statement was based on the common knowledge that pure titanium is very strongly embrittled at room temperature by the presence in it of hydrogen, and that many titanium alloys are likewise embrittled at room temperature by even very small amounts of hydrogen. Instead of leaving the matter at that, a discovery now requires the above sweeping statement to be modified by pointing out that while it was previously believed that hydrogen had only deleterious effects in titanium alloys, it has unexpectedly been found, according to the invention, that the hot workability of titanium alloys is actually improved by hydrogen. Thus, if an alloy, which is otherwise difficult to hot work or requires very high working temperatures, is melted in the presence of hydrogen so that it can take up the gas, the resulting hydrogen-containing alloy is much more easily hot worked than the hydrogen-free alloy. Admittedly, in order to obtain good mechanical properties in the hot worked product, it is generally necessary to remove the hydrogen after the hot working has been completed. The amount of hydrogen required is between 0·05 and 1 per cent, alloys which are more difficult to hot work requiring more hydrogen. Since, moreover, such alloys usually are able to take up only a limited amount of hydrogen, as much hydrogen as will dissolve should generally be incorporated. A particular example of the beneficial effects of hydrogen is provided by titanium-aluminium alloys, which, if they contain more than 6 per cent aluminium, are very difficult to hot work and require very high working temperatures, so much so that such alloys could not be used commercially. Introduction of hydrogen by arc melting in an atmosphere of 75 per cent argon and 25 per cent hydrogen, or by heating in hydrogen at 900°C., renders such alloys capable of being forged and hot rolled at 750°-950°C. with considerable deformations, and with little or no cracking. After hot working, the hydrogen content of the alloys is reduced below 0·002 per cent by heating to 1,000°C. in a high vacuum.

Skimmer

DESIGN — MELT COMPOSITION AND CONDITION — POURING TEMPERATURE

Control Techniques for the Small Foundry

By A. R. MARTIN, B.Sc., A.R.S.M.

A VERY large proportion of the castings produced for the commercial market at present are "space fillers." Dimensional tolerances are usually the only requirement, since the component would be strong enough to do its job cast in any available alloy. Aluminium casting alloys are frequently used because of the ease of fabrication to close limits by the gravity die-casting process which, in turn, allows reduced machining costs.

The small foundry, with its low overheads, comes into its own in this field, offering quick delivery of "one off" jobs and highly competitive prices for long runs.

More demanding end-use requirements impose additional costs because of the extra effort involved or as a result of lower recoveries. Inspection costs will also be increased. Moreover, orders for short run or "one off" castings do not allow scope for technique development. There are few non-destructive tests available to the founder, and destructive tests reduce the recovery by the number of castings destroyed in the test. The most critical end-use requirements can only be met by laboratory control at all stages. For the small foundry not equipped with a laboratory, the answer lies in aiming for straightforward techniques based on sound principles that are appropriate to the method of working.

The principles on which such techniques may be based have been set out in considerable detail in Papers presented at an Institute of Metals Symposium on the Metallurgical Aspects of the Control of Quality in Non-Ferrous Castings.[1] Although these Papers were written by metallurgists for metallurgists, the information contained in them, and brought out in the subsequent discussion, does not only find application in the foundry equipped with laboratory facilities.

The purpose of this article is to suggest that, by applying known and well established principles to:— (i) the design of the casting and its mould, (ii) control of the melt composition, (iii) control of the melt condition, (iv) control of the pouring temperature, any foundry may expect to achieve a fair measure of casting quality.

The only requirements are:— (a) effective supervision of details, (b) records of techniques, (c) inspection records.

The most convincing evidence of control is the achievement of consistent results (inspection records). Consistent results will depend on consistent working conditions (records of techniques). The control of casting quality is therefore dependent on the application of consistent working conditions rather than as a result of a post mortem by the inspection department.

Casting and Mould Design

The design of the casting and its mould are one and the same operation. The principles of casting design are too well known to need repetition here. It should also be unnecessary to point out that these principles apply quite independently of the method of casting and that castings produced in shell moulds for example, require to be fed as adequately as they would be if produced in sand moulds. They are so frequently ignored that it is now accepted that the foundryman's art consists of reversing naturally occurring temperature gradients in order to establish directional solidification in the required direction and in supplying feed metal to large sections, isolated from the risers by thin walls calculated to solidify in a fraction of the time.

In many such cases, techniques may be developed that produce satisfactory recoveries but in such cases the quality is not inherent in the technique but depends on supervision of the operation and inspection of the casting. This is not "technique control." Two examples of recently developed techniques that materially assist in providing consistent working conditions are: —(a) insulating riser sleeves for insertion in sand moulds, (b) automatic control of the gravity and pressure die-casting processes.

Because of their thermal insulation and shape, insulating riser sleeves provide adequate feed with the minimum of metal, the volume of the feed metal does not vary, and because they do not react (at any rate with aluminium alloys) they may be placed in contact with the surface of the casting, eliminating the usual neck.

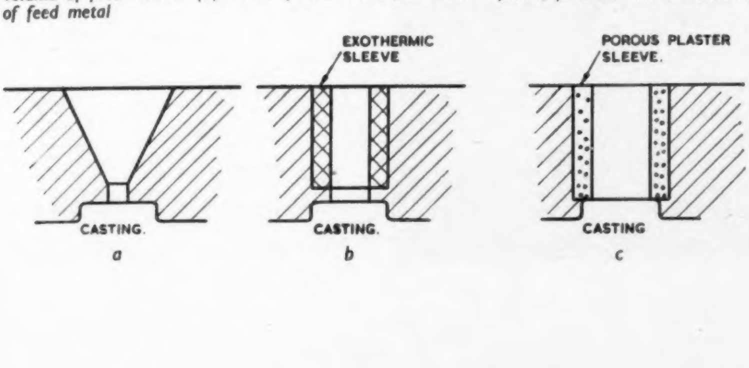
This last point is of particular importance since, all too frequently, the junction between the riser and the casting is necked down to allow the riser to be broken off or to provide a witness for sawing. This neck may easily solidify before either the casting or the riser, making the riser completely ineffective.

Mechanization is now being widely applied to the gravity die-casting process and Fletcher[2] refers to mechanization as the greatest single advance in the art. The pressure die-casting process is already mechanized so that for either process it is a relatively short step to apply automatic sequence control to the various operations of opening and closing the die. To delay the withdrawal of the various core pieces and the opening of the die until solidification is complete, process timers may be included in the circuits and, once set up and running smoothly, an extremely high order of consistency in casting conditions can be maintained.

In order to take full advantage of these possibilities, automatic control of the melt temperature is essential. Automatic temperature control is seen at its best in the low frequency induction holding furnace although it is possible to apply automatic control to other types of furnace. The size of the furnace must be related to the rate at which molten metal is withdrawn for casting since it is asking too much of any control system to cope with the wide fluctuations in temperature that occur when large amounts of molten metal are withdrawn and replaced by fresh metal from a bulk melting furnace.

During the manual operation of a gravity die, thin section cores may be quenched between casting operations to prevent them becoming overheated. Re-design of these parts to allow cooling water to be passed through them continuously removes the erratic temperature fluctuations that otherwise occur. Water-cooling the body of the die in selected areas produces a far

Diagrams showing riser arrangements. (a) Conventional riser: the diameter of the neck and volume of the conical portion may vary over a wide range. (b) Exothermic sleeve, must be separated from the casting by moulding sand to prevent damage to the surface; provides constant volume of feed metal. (c) Porous plaster sleeve, no neck required; provides constant volume of feed metal



General purpose gravity die-casting machine, die closed, pouring in progress

more consistent "heat balance" in the die than is possible by variations in the thickness of the die coating and results in more positive removal of the heat from the casting. Water-cooling confers advantages when applied to manually operated dies but is essential to the mechanized die.

Control of Melt Composition

Process scrap inevitably arises in a foundry in the form of runners and risers. If several alloys are being remelted then scrap segregation, which involves nothing more than good housekeeping, is a vital necessity. Chemical analysis will detect the consequences of mixed alloys but will not prevent them. Some foundries take the precaution of remelting in bulk all their process scrap which is then poured into ingots and analyzed before re-use. This course of action does nothing to prevent contamination and, moreover, if serious contamination does take place, it defeats its own object in that a large melt has been rendered useless (or at best, usable only at a cost).

The founder, whose melting facilities consist only of small crucible furnaces will purchase pre-alloyed ingot and will not normally consider making any additions, and in fact it may not be practicable to do so. If each furnace charge consists only of pre-alloyed ingot, the composition will vary from batch to batch of ingot. By including a proportion of process scrap in the charge these variations are reduced.

General purpose gravity die-casting machine, die opened and casting being extracted

If consistent melting conditions are aimed at, such that losses of elements due to oxidation or gains in impurities due to pick up from refractories or furnace tools are known and are consistent, other advantages accrue, which will become apparent in the following example.

To take a practical case, assume that a founder is producing castings in LM.11 alloy. The impurities in this alloy should be as low as possible. It is also assumed that this founder is melting in small crucible furnaces and makes no additions to his charges other than process scrap and that he has established a consistent remelting practice that limits the pick up of iron at each remelting to 0·03 per cent.

If a batch of pre-alloyed ingot is supplied with an iron content of 0·12 per cent, the iron content of a melt using only this ingot would be:

$$e_1 = 0{\cdot}12 + 0{\cdot}03 = 0{\cdot}15 \text{ per cent.}$$

If the process scrap from this melt is included in the next melt with an equal weight of ingot, the iron content will be increased to:

$$e_2 = 0{\cdot}12 \times 0{\cdot}5 + 0{\cdot}15 \times 0{\cdot}5 + 0{\cdot}03$$
$$= 0{\cdot}17 \text{ per cent.}$$

The iron content increases to 0·18 per cent at the next remelting and levels out at this value.

For the general case, assume that a batch of ingot contains e per cent of alloying element of which g per cent is gained or lost at each remelting. If the first melt contains only ingot, the composition of the melt will be:

$$e_1 = e + g$$

(g counted positive for melt gain and negative for melt loss). As before, process scrap of composition e_1 is mixed with the ingot, the proportion of the scrap being p (p less than 1).

$$e_2 = (1-p)e + p\ (e+g) + g$$

From this it follows that at the next remelting

$$e_3 = (1-p)e + p(e + pg + g) + g$$
$$= e + p^2g + pg + g$$

and $e_4 = e + p^3g + p^2g + pg + g$

Rewriting the correcting terms containing g in the reverse order provides the series

$$g + pg + p^2g + p^3g \ \ldots\ldots\ldots$$

which is a geometric progression and the sum a (a = accumulated melt loss or gain) to n terms (n = number of times the process scrap is circulated) is:

$$a = g\,\frac{(1-p^n)}{1-p}$$

As n tends to infinity

$$a = \frac{g}{1-p}$$

and this expression is illustrated in the graph opposite.

This chart may be used in several

ways. Returning to the example of iron pick up in LM.11 alloy, the known quantities were the iron picked up at each remelting and the amount of process scrap in the charge. Tracing vertically upwards to the point of intersection of the line for 50 per cent scrap and the curve for 0·03 per cent gain and from this point horizontally across to the axis for accumulated melt loss or gain yields a value of 0·06 per cent. The iron content therefore levels off at a value of:

$$0{\cdot}12+0{\cdot}06=0{\cdot}18 \text{ per cent}$$

which confirms the calculated value. It might be permissible to allow the iron content to rise to 0·2 per cent. This fixes the allowable accumulated melt gain at:

$$a=0{\cdot}20-0{\cdot}12=0{\cdot}08 \text{ per cent.}$$

Tracing across from this ordinate to the curve for 0·03 per cent gain at each remelt a value of 62 per cent is obtained for the amount of process scrap that may be included in the charge.

Melt losses may be determined using this same chart. Assume a founder remelting LM.10 alloy has established a practice that limits the loss of magnesium to 0·3 per cent at each remelting. If ingot is supplied with a magnesium content of 10·8 per cent and it is considered that the melt magnesium content should not fall below 10·3 per cent the accumulated melt loss will be:

$$a=10{\cdot}8-10{\cdot}3=0{\cdot}5 \text{ per cent}$$

Tracing horizontally from $a=0{\cdot}5$ to the point of intersection with the curve for 0·3 per cent loss or gain and from this point vertically downwards to the percentage scrap in charge axis yields a value for 40 per cent process scrap.

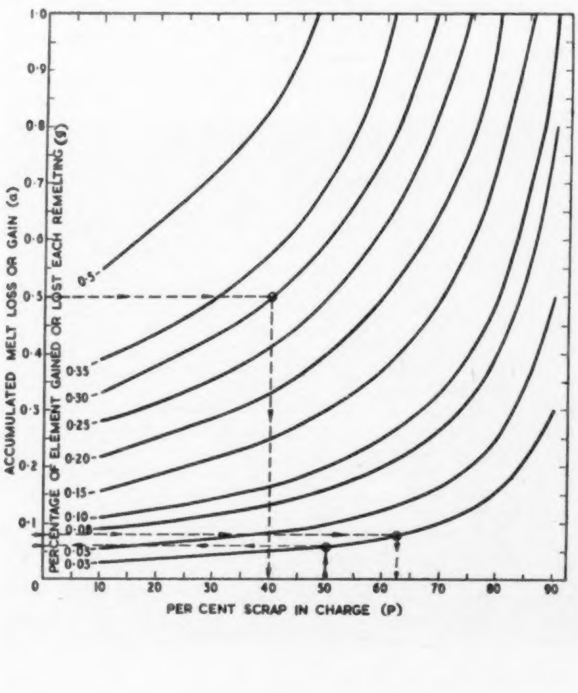
When small batches of ingot are remelted so that the composition of the process scrap fluctuates, it obviously detracts from the value of this method.

Hand-operated die for casting pistons two at a time. The die halves are water-cooled

The answer is to use the largest available ingot batches or to mix smaller batches.

The direct reading spectrograph has been advanced as the ideal instrument for control of foundry alloy compositions.[1] The speed with which analyses may be produced certainly makes it very attractive. Whilst the accuracy of the results it produces is not in question, it should be borne in mind that it gives the composition of a very small sample of metal. In casting alloys containing high concentrations of alloying elements quite surprising amounts of segregation may take place in quite small chill cast samples. To some extent the amount of the segregation may be reduced by attention to the casting technique but the sample will still have to be carefully sampled; just as for chemical analysis, if representative (as distinct from accurate) results are to be obtained. The speed of operation is such that in extreme cases, determinations may be made at several points on a sample and the results averaged to obtain a representative level.

The cost of installing a direct reader may include the cost of a temperature-controlled, air-conditioned room in which it is to operate. Against this, the writer has seen foundries in the States employing direct readers in rooms that were neither temperature-controlled nor air-conditioned. These instruments were calibrated by means of purchased standards that were sparked with every batch of samples. Reliance was placed on the fact that the ambient temperature and humidity would not change appreciably during the short space of time in which the samples were analysed and, in fact, the method appeared to be justified.



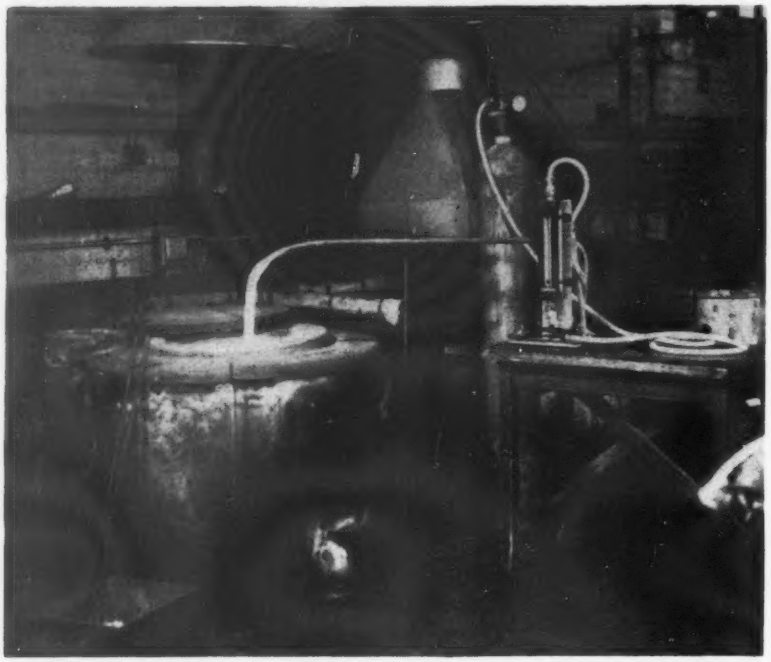
Curves showing accumulated melt loss or gain at each remelting according to percentage of scrap in melt

Control of Melt Condition

On the subject of melt quality, all authors stress the importance of good housekeeping and rightly so. It is a requirement that can be met by any foundry and the cost of the effort is small in comparison with the dividend. Briefly summarized, good housekeeping involves: — (a) segregating scrap by alloys; (b) the charge components must be clean and in good condition—it is also a requirement that process scrap should be of a suitable size; (c) the melting equipment (furnace tools, crucibles etc.) should be clean and in good condition and properly coated where this applies.

There is little point in producing melts containing excessive amounts of oxides and gas and then applying elaborate and expensive treatments to clean the melts.

Control of the melt temperature is desirable to prevent undue losses by oxidation. Moreover, aluminium alloys held for long periods at high tempera-



Arrangement for control of gas content in bale-out furnace [Courtesy International Alloys Ltd.

tures will absorb hydrogen and solidify with a coarse grain.

Control over losses by oxidation makes for control over the chemical composition as outlined in the previous section.

Several methods are available for refining the grain of aluminium alloy castings although the small founder may rely on the fact that the ingot used has been grain-refined by the supplier. Provided the melt temperature is kept under reasonable control it is safe to do so but the nuclei responsible for the refinement may be dissolved by prolonged or repeated exposure to high temperatures and then become ineffective.

The advantage of automatic control of the holding furnace temperature has already been mentioned. Automatic control of the melting furnace temperature is also worth consideration.

The subject of grain refinement raises the general question of metal treatments which may be classified as:— (a) the prevention of oxidation; (b) the removal of oxides; (c) grain refinement (d) degassing control of gas content (e) modification of aluminium alloys.

From the point of view of developing techniques that make for consistent working conditions all that need be said is that where alternative treatments exist, select the one suited to the furnace in which the treatment is to be carried out. This consideration should override any question of the relative costs of the methods. Where only one method of treatment exists then, if the furnace equipment is not suitable, the treatment may be carried out in a transfer ladle or pouring ladle although particular attention must be paid to the rapid temperature drop in small ladles.

Most of the oxide encountered will have been introduced into the melt as the oxide coatings on the surfaces of the ingots and process scrap. Cover fluxes are available for both crucible and reverberatory type furnaces.

The elements necessary for nucleation may sometimes be added as hardener alloys or as fluxes. Such small additions are required that, unless the melting is being carried out in large capacity reverberatory furnaces, fluxes yield more consistent results than hardeners.

Removal of hydrogen from molten metal is achieved by bubbling a suitable purging gas through the melt. The gas may be obtained from cylinders or as a result of the breakdown of proprietary degassing tablets.

Efficient degassing requires a long time of contact between the bubbles of the purging gas and the molten metal and to fulfil this condition a deep crucible, preferably of small surface area, is required. It is a waste of time and purging gas to attempt to degas a melt in a shallow reverberatory furnace of large surface area. Under these conditions the treatment may be carried out in the transfer ladle or pouring ladle. A further good reason for doing so is that in any case the appropriate time to carry out the treatment is immediately prior to casting. A short settling period should be allowed to enable non-metallic inclusions to float to the surface and be removed.

For the production of certain types of commercial aluminium alloy gravity die-castings, hydrogen is deliberately introduced into the melt in order to minimize shrinkage and cracking troubles. The usual method of introducing the hydrogen is by way of proprietary preparations based on salts with large amounts of water of crystallization. Immediately following this treatment the hydrogen content of the melt may be excessively high, whereas after several castings have been poured further treatment may be necessary to restore the level. As an aid to more consistent working conditions, the methods of introducing hydrogen proposed by Scheuer and by Baker[1] merit consideration. The basic principle underlying both methods is that the hydrogen is introduced by bubbling a steady stream of a mixture of gases through the melt. The rate at which the gas mixture is introduced into the melt is varied to adjust the hydrogen content to within the desired range and the level may be maintained. Scheuer[1,3] also describes a "hot spot" die for producing test plates to indicate the level of gas content which appears to be a thoroughly practical foundry control test.

Melts of aluminium silicon alloys may be treated either with metallic sodium or with fluxes containing sodium fluoride. Sodium metal is added in such small quantities that again for consistent results it is better to use the flux addition for small melts. Sodium metal is best added to a deep crucible so that if a shallow bath of large surface area has to be treated, it is best to make the addition to the transfer or pouring ladle. Flux treatment of the bath is not a good alternative in this case, not only because of the high cost of the flux relative to that of sodium metal, but because of the severe attack on the furnace refractories by the flux.

The characteristics of the unmodified 12 per cent silicon alloy are its fluidity and the fact that, having no freezing range, the contraction cavity is a well defined pipe. When the alloy is modified it loses fluidity to quite an appreciable extent. If the treatment has been carried out with metallic sodium, the well defined shrinkage cavity is dispersed as gas porosity and the shrinkage characteristic of the alloy appears to have been altered. If the treatment has been carried out with vacuum melted sodium or with flux, the hydrogen introduced will be considerably less and the modified metal will have the shrinkage characteristic of the unmodified metal. Particular attention will have to be paid to ensure that castings poured from melts so treated are adequately fed.

References

1 "Metallurgical aspects of the control of quality in non-ferrous castings." Inst. of Met. Symposium, London, 1957. Discussion *J. Inst Met.* 1957, **85,** 518.

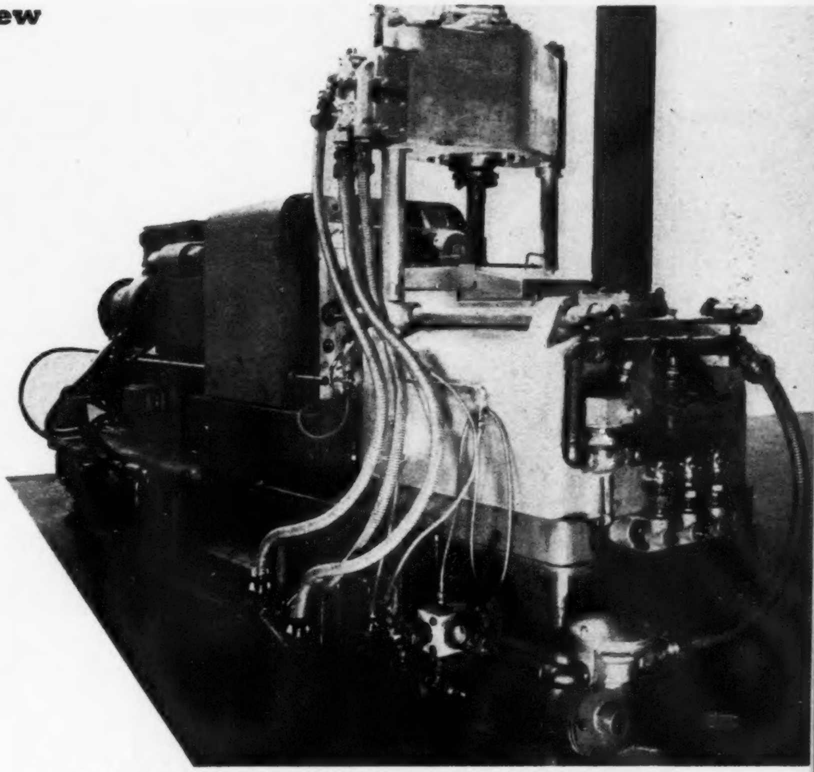
2 L. Fletcher; *Met. Ind.*, 1958, **93,** 129, 149.

3 E. Scheuer, S. J. Williams and J. Wood; *Met. Ind.*, 1954, **85,** 47, 63.

(To be concluded)

Pressure Die-Casting Review

High Speed Die-Casting



The E.M.B. No. 12A die-caster, showing the rear and furnace end of the machine

IN considering the installation of a new die-casting machine, the die-caster must take account of many factors, and, for most foundries, one of those factors would inevitably be the adaptation of existing dies to the new machine. The importance of this aspect at once becomes clear when it is appreciated that the high cost of dies involves even a small foundry in a capital outlay of several thousands of pounds.

This factor has been one of the primary concerns of the E.M.B. Co. Ltd. in introducing their new die-casting machine, the 12A—a machine that provides manual or automatic operation while being similar in size and capacity to the widely-used manually-operated No. 12 that the company has been building for some years. These machines, fitted with a hot chamber head, will cast zinc, lead and tin alloys. A cold chamber head is quickly interchangeable, enabling the same machine to deal with aluminium, magnesium and copper alloys.

Like all E.M.B. machines, operation is by compressed air, giving a much greater range of injection speeds—from 200-1,750 ft/min.—although in normal operation, controlled speeds around 750 ft/min. are usual.

The high injection speed, which is only possible with an air-operated machine, governs the thickness and density of the castings. With a slow injection speed the casting must be thick to prevent freezing before the cavity is filled. It is claimed this machine enables the same casting to be made much thinner, thereby saving metal and at the same time improving the surface for subsequent finishing processes.

The machine embodies a powerful toggle-operated lock, powered by compressed air and controlled by a hydraulic dashpot that ensures "cushioning" as the dies close, thus preventing damage to expensive dies. An added safety device for fully automatic machines is the low pressure closing of the dies. If flash builds up, or a casting fails to fall clear, the dies do not close tightly together and the high pressure lock is prevented from coming into operation.

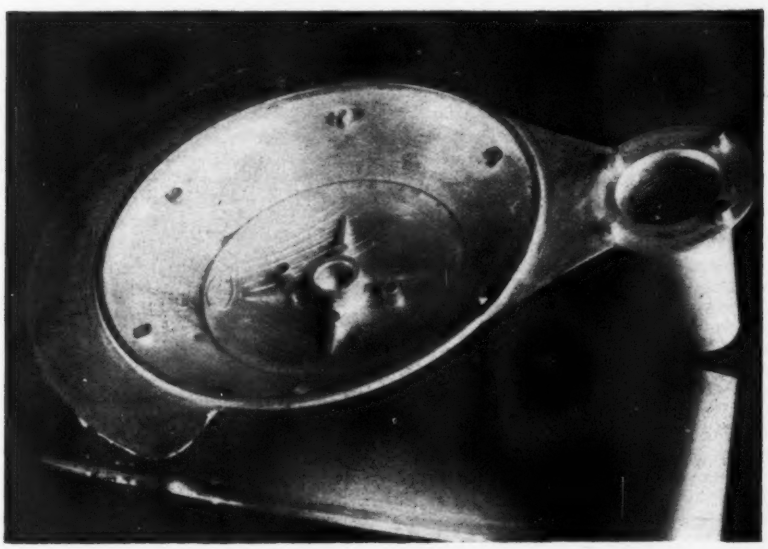
A light, hand-operated guard, fitted with toughened glass windows, is mechanically interlocked with the movements of the platen and the injection valve.

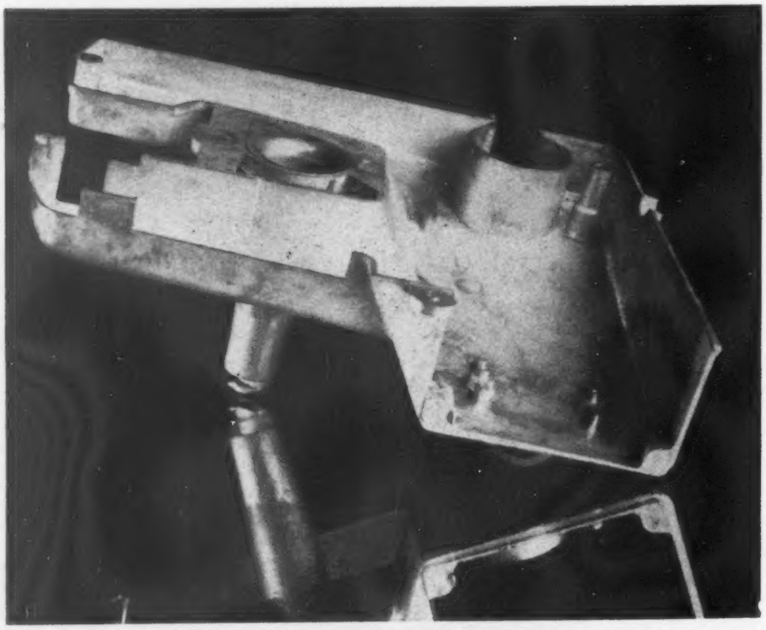
A sensitive hand control of the machine is provided for setting up intricate dies.

Automatic operation gives timed control for injection, freezing and die opening, all independently adjustable.

The automatic control unit is dependent on an air motor built into the locking head. Power is derived from a double acting air cylinder which rotates (by means of a rack) the cams controlling the air and oil valves operating the machine. The unit has four dials for adjusting: (1) the time of opening the dies, (2) the time of freezing, (3) the time of packing the casting, and (4) the position of the fast ejection part of the stroke. An emergency stop is incorporated, by means of which the movement of the platen in either direction can be stopped instantly.

Pressure die-casting in zinc alloy for base of companion set





Above : One half of a body for a toy sewing machine

Left : Casting for side-light housing

The capacity of this machine is approximately 6½ lb/shot of zinc alloy with a die locking force of 120 tons, and an injection pressure of 2,100 lb/in^2 down to 1,350 lb/in^2. Platen size is 20 in. by 20 in. and the space between the tie bars 12½ in. by 12½ in. The maximum die height is 15 in. and the minimum is 6 in.

An interesting feature of all sizes of the new ranges of E.M.B. machines is that steel castings and forgings are being used wherever possible to replace cast iron, an important step in view of the higher locking pressures being used in the latest machines. This does not, of course, apply to the main bed of the machine which is of cast iron, or in the case of larger models, fabricated.

The accompanying illustrations show a number of typical die-castings, as well as the machine itself. Two of the die-castings—the toy sewing-machine body and the sidelight housing—show clearly the extensive projected area and thin wall sections which are a feature of castings produced on machines with high injection speeds. In the former, the wall thickness is approximately 0·060 in., and in the sidelight housing it is 0·055 in. The other casting illustrated is the base for a companion set, the domed surface of which has to take a high quality chrome finish. Polishing has been reduced to a minimum as a result of the freedom from flow marks, cold shuts and inclusions.

STANDARD SPECIFICATIONS

Nickel Copper Alloy Castings (B.S. 3071 : 1959). Price 4s. 0d. Nickel and Nickel Alloys—Sheet (B.S.3072: 1959). Price 5s. 0d. Nickel and Nickel Alloys—Strip (B.S.3073: 1959). Price 5s. 0d. Nickel and Nickel Alloys—Tube (B.S.3074 : 1959). Price 5s. 0d. Nickel and Nickel Alloys—Wire (B.S.3075 : 1959). Price 4s. 0d. Nickel and Nickel Alloys—Rods and Sections (B.S.3076 : 1959). Price 5s. 0d.

THIS series of standards for nickel and nickel alloys supersedes the earlier series, B.S. 1525-1537, issued in 1949.

B.S.1537 referred to one nickel copper alloy, but its successor, B.S.3071, includes requirements for two further alloys with higher silicon contents; they have been added to meet Service requirements.

The standards for wrought materials have been regrouped so that one document applies to each wrought form, as in the B.S.1470-1477 series for aluminium and in the schedules of wrought copper and copper alloys which are in course of preparation.

The requirements for the three materials included in the earlier series of standards have been amended, and a fourth material—low carbon nickel—has been included for some forms. Code numbers have been allocated to them and are used throughout the series, but associated with the British Standard number for each wrought form.

Sheet and strip material are now the subject of separate standards.

Men and Metals

As announced in this column last week, **Professor A. J. Murphy** was elected President of the Institution of Metallurgists at the annual general meeting held in London. At the same meeting, the following elections were also announced:—President-Elect: **Mr. W. E. Bardgett,** B.Sc., A.M.I.Mech.E., F.I.M.; vice-presidents: **Dr. W. O. Alexander,** B.Sc., Ph.D., F.I.M., and **Professor J. W. Cuthbertson,** D.Sc., A.M.I.E.E., F.I.M. Ordinary member of Council elected by Fellows: **Mr. L. Rotherham,** M.Sc., F.Inst.P., F.I.M. Ordinary members of Council elected by the Associates: **Dr. C. S. Ball,** B.Met., Ph.D., A.I.M.; **Mr. Desmond Lewis,** B.Sc., A.I.M., and **Dr. I. G. Slater,** M.Sc., Ph.D., F.I.M.

Yesterday (Thursday) evening at the annual general meeting of the Institution of Mining and Metallurgy, held in London, **Dr. J. H. Watson,** C.B.E., M.C., A.R.S.M., B.Sc., Ph.D., was inducted President of the Institution for the ensuing year.

PROPERTIES — DESIGN — PRODUCTION METHODS — HALL-MARKING

Quality in Copper-Base Alloy Castings

By F. HUDSON, F.I.M.

Increasingly exacting demands by engineers are being made for higher quality castings, especially since the advent of high speed engines such as are being used today in many fields of propulsion. Still greater demands are likely, and while some of these may be met by techniques associated with the processing of the newer metals, there is still much to be done in the improvement of castings in the well-known and well-tried alloys. This article discusses some of the problems facing founders of copper-base alloys: it was presented as a lecture earlier this year to the Association of Bronze and Brass Founders in London and Wolverhampton.

FOR many years the demand for castings exceeded the rate of supply and this created a seller's market. The buyer was content to take what he could get. Within the last 12 months, however, conditions have changed and a sign of the times, consequent upon reduced foundry activity, is the increasing demand by buyers of castings that specifications be met and in some cases tightened up. At a meeting sponsored by the American Society for Metals, held at Cleveland, Ohio, last October, the subject "Design and Specification for High-Quality Castings"[1] was discussed.

Reporting upon castings for aircraft and missiles, Sparling (Convair-Pomona Division) mentioned that such components should measure up fully to specification test values. In this connection, integral parts of the casting subjected to tensile and other tests would be more significant than values obtained from separately-cast test bars.

In connection with castings for the petroleum-refining industry, Rees and Manuel (Socony Mobil Oil Co.) stated that pressure-resistant castings of high quality were required for valves and fittings, etc., capable of withstanding pressures ranging from a vacuum to 5,000 lb/in^2 over the temperature range -29°C. to 816°C. A service period of 10 years is expected. The authors felt that standards should be set up for (a) soundness, and (b) minimum quality, and that the foundryman must co-operate with the user to improve products.

Elsey (Pennsylvania Railroad Co.) commented upon the position of castings in the railroad industry and suggested that a saving in the weight of castings could be achieved through research on design. In addition some means were necessary for the foundryman to be able to prove that his control of quality was so thorough that the purchaser would not be required to spend additional money in providing a duplication of inspection. (In this connection it might be mentioned that in the U.S.A. suppliers to the Navy are now responsible for all inspection requirements. Naval inspection only covers the records, not the castings themselves.) Also, the costs of rejection ought to be seriously accounted for and the foundrymen's engineers and representatives should be more knowledgeable about the product they were delivering.

Whitney (Kearney and Trecker Corporation) dealt with machine-tool requirements and pointed out that the industry was built upon the need to purchase "one casting only" in many cases. He suggested that measures which increased casting costs, but which saved money in other directions, were desirable elements for foundrymen to study and they should choose either to spend more money on technical control or lose the corresponding amount in scrap.

In reading the report of this meeting one gets the impression that the buyers and users of castings in the U.S.A. are not altogether satisfied with the present standard of quality and they would like to see some improvement effected. If a meeting of this kind were held to-day in Britain it is highly probable that the conclusions would be of a similar nature.

So much for the present. What about the future? For a moment let us go back 50 years to life as it was at the dawn of the twentieth century. The motor car was still in its infancy. There were no aeroplanes, gas turbines, guided missiles, radio, radar, television, or nuclear power. There were few oil-refineries, for there was little demand for petrol. The petroleum industry is virtually a post-war growth, and what an astounding growth it has been! No less than £558 million worth of petroleum equipment has been purchased in this country for the five-year period 1953-1957, and the rate of growth is still increasing. These are just a few of the new developments which have taken place during the past 50 years and there are many more.

What is going to happen in the next 50 years? It is probable that new developments will be even greater and more numerous than in the first half of the present century. For example, take the subject of marine engineering. In the small boat field the Americans are ahead of the United Kingdom and Europe. There is a huge market in North and South America for pleasure craft and these are now being fitted with very large outboard motors developing up to 70 h.p. giving speeds of 45 to 50 miles per hour. Non-ferrous castings form a major part of these motors. For example, a one-piece aluminium-alloy die-casting forms the cylinder block, intake manifolds, and upper crankcase. Cast iron cylinder sleeves and a bronze half-bushing are all cast in place. The cylinder block casting weighs about 37 lb., and the die about 6½ tons. Propeller speeds are high and it is customary to fit high-tensile aluminium bronze propellers. It may be of interest to note that these large outboard motors will shortly be manufactured in this country.

At the moment the application of hydrofoils to ships' hulls is being given serious consideration by American marine engineers and development work has already been successfully accomplished relative to their use on small craft. Hydrofoils are small fins fitted to the side of the hull and they act in a similar way to the flaps on an aircraft's wing. By varying the pitch of the hydrofoils, when the ship is travelling at speed, the hull can be raised out of the water so that it planes along the surface. This increases the speed of the ship enormously and eliminates much of the motion caused by rough seas. In the autumn of last year the writer attended a meeting of naval architects and marine engineers, held in the United States, when a Paper was presented on this subject and it was evident that the development of hydrofoils in America has now reached the stage when they can be effectively applied to small craft, up to 100 tons in weight, enabling speeds of 80 to 100 miles per hour to be achieved. In fact the author of the Paper in question stated that in view of the results already obtained he considered that it was quite practicable to obtain speeds in this range from ships of up to 3,000 tons by the proper use of hydrofoils.

From the discussion that followed it is evident that better materials will have to be developed for vessels of this type. For example, at speeds above 50 knots even high-tensile aluminium bronze propellers are not too satisfactory and it will not only be necessary to develop improved alloys to meet the more strenuous service conditions involved but the founder will also have to be able to produce castings of guaranteed quality. Incidentally these requirements are even now needed in Britain in connection with latest developments on fast motor torpedo boats powered by gas turbines.

Nuclear power, the conquering of space, further developments in the chemical and petroleum engineering fields, such as the transportation and storage of liquified natural and petroleum gas, are just a few of the many new developments that the engineer will have to cope with in the

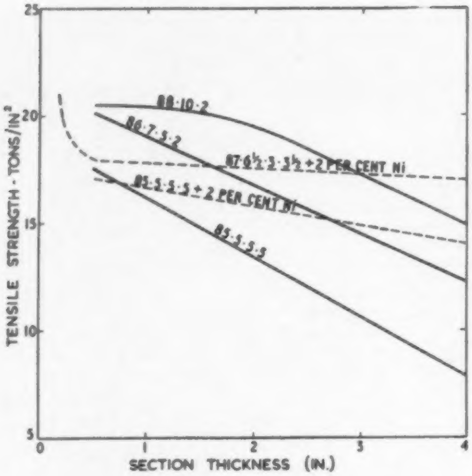


Fig. 1—Effect of section thickness on the tensile strength of gunmetal castings. None of the standard gunmetals is capable of providing the ideal combination of requirements needed for the production of quality castings, namely a uniformly high level of mechanical properties and pressure-tightness in castings of variable section. An alloy containing 6-7 per cent tin, 3-4 per cent zinc, 3-4 pcr cent lead, 1½-2½ per cent nickel, balance copper, will provide this ideal. Furthermore with such an alloy the mechanical properties of castings can be related to those obtained from separately-cast test bars.

years to come and there is no doubt that castings of one kind or another will play an important part. Greater attention will, however, have to be given to the subject of casting quality if founders are to meet the industrial needs of the future.

What can one do to obtain higher quality in the field of copper-base alloy castings? There are several points which might receive consideration.

(1) The founder must have greater knowledge of the properties of the actual castings produced and how such data is related to that obtained from separately-cast test bars. A data book giving such information would be invaluable to the designer.

(2) Castings must be correctly designed to facilitate the production of quality castings but this cannot be done properly unless information is also available on the properties of castings.

(3) Founders must use up-to-date production methods best suited for the production of quality castings.

(4) Founders must ensure control of casting quality through adequate inspection and routine tests.

(5) Some system should be introduced for hall-marking quality castings, or for certifying approved foundries capable of producing such castings, and every effort should be made to educate the customer on the advantages arising from such a system.

Properties of Castings

A certain amount of work on the properties of castings has been done by a few of the more progressive foundries, making alloy-steel and light-alloy castings for use in aircraft and missiles, and the results obtained have been found extremely valuable, not only in promoting new developments but also in providing greater confidence in the quality of castings. Very little information has been published on the properties of castings in copper-base alloys although such information is badly needed by design engineers.

In order to stimulate greater interest in this subject, the writer and two colleagues presented a Paper last year to the International Foundry Congress at Liège on the "Properties of Copper-Base Alloy Castings"[2] when it was shown that alloys with a short freezing range, such as aluminium bronze and high tensile brass, were not unduly sensitive to the effect of section thickness, and castings could be produced in these alloys with a high level of mechanical properties, approaching those obtainable from separately-cast test bars. In other words, provided the casting is sound, the engineer can obtain a good idea of what the properties in the casting are likely to be and he can use these as a basis for good design.

In the case of alloys with a long freezing range, such as tin bronze and gunmetal, the properties of castings may vary widely with section thickness and may be unrelated to those obtained from separately-cast test bars. Composition has an important bearing on the section sensitivity of gunmetal alloys. In 85/5/5/5 gunmetal castings the mechanical properties in thick sections are seriously reduced through the presence of massive grain-boundary lead segregates, in addition to a variable amount of microporosity. The addition of 2 per cent nickel, however, seems to promote a much more uniform and higher level of properties in castings of varying section. In the case of 88/10/2 gunmetal castings the fall in properties is less, as lead segregates are absent, but still appreciable due to the incidence of microporosity. The properties of 86/7/5/2 gunmetal come in between the 85/5/5/5 and 88/10/2 compositions.

All the standard gunmetals in use today have been evolved by trial and error and, as a result of systematic study, compositions may have to be modified to obtain an improvement in casting quality. None of the existing gunmetals is capable of providing the ideal combination of properties needed for the production of quality castings, namely a uniformly high level of strength, ductility, and pressure-tightness in castings of variable section.

It would seem that an alloy containing about 6-7 per cent tin, 3-4 per cent zinc, 3-4 per cent lead, 1½-2½ per cent nickel, balance copper, may provide this ideal. Such an alloy would be easy to handle in the foundry and would be better suited for the production of quality castings than any of the gunmetals in use today. Gunmetal castings in this modified composition would be less sensitive to the effect of casting section and, if properly made, should have a tensile strength of not less than 16 tons/in^2. As a matter of interest it might be mentioned that, since the publication of the Paper, the mechanical properties of step-bar castings in this improved alloy have now been determined and the tensile strength obtained on sections varying from $\frac{3}{16}$ to 4 in. in thickness is shown in Fig. 1.

Before definite recommendations can be made, further work will obviously have to be done and in this connection it is gratifying to note that the development of improved gunmetal compositions is already receiving the attention of the British Non-Ferrous Metals Research Association in this country and the Bureau of Mines in Canada. Obviously if a gunmetal can be evolved, not unduly sensitive to the effect of section thickness, which will produce castings with a level of mechanical properties related to those obtainable from separately-cast test bars then a useful advance in non-ferrous metallurgy will have been made of considerable benefit to both founder and engineer.

Design of Castings

In order to obtain castings of higher quality it is essential that they be correctly designed and in this connection there is a very real need for greater co-operation between founder and designer. Far too many castings are badly designed, not because of the engineers who conceived them, but because of founders who, knowing that the design is wrong, persist in trying to make them on the basis of "let's have a go and hope for the best."

An attitude such as this will not help the foundry industry to produce better castings or meet the needs of the future. Every foundryman worthy of his name should be recognized as a specialist in his field capable of advising the engineer on every matter connected with casting production. He should be able to tell the engineer all about the properties of castings, and how these are affected by design, as well as the best methods of production. How can the engineer make a proper job of designing a casting if the founder cannot provide data on the properties to be expected? How many foundrymen could supply such information?

Every foundryman must take a greater interest in both the design and properties of castings and see that the knowledge gained is applied in actual

practice. This will demand more intimate co-operation between founder and engineer than exists today. The British Steel Founders Association, The Gray Iron Founders' Society, Inc. and the Centre Technique des Industries de la Fonderie, have made a useful start in this direction. They have all issued publications of one kind or another and their example could well be followed by the Association of Bronze and Brass Founders. However, most of the information provided, useful as it is, only deals with the correct positioning and shape of the various sections ultimately put together to form a casting. In the case of many copper-base alloys such information must be implemented by data on the properties of castings if it is to be of full value to both founder and designer. Many castings are much heavier than they need to be, because of the lack of such information, and a data book relating properties with design could help enormously in reducing the weight of castings as well as improving quality.

Effect of Production Methods

When the problem of design has been settled the next consideration is the effect of production methods on casting quality. Melting practice, pouring temperature, running and feeding methods, and type of mould employed, are probably the major factors involved. All of these have received a great deal of study, by research and trade associations, by progressive foundrymen throughout the world, over a long period of years and it would serve no useful purpose to review these in detail in this article.

It is, however of interest to observe that in the mass production of quality castings some manufacturing methods are better than others. In this connection one has in mind the gravity die-, centrifugal-, and continuous-casting processes. Copper-base alloy castings, particularly tin-bronze and gunmetal, made by these methods are generally of a much higher standard of quality, both as regards soundness and mechanical properties, than castings made in ordinary sand moulds. The reason for this is probably due to the fact that founders using these special processes exercise greater control over such variables as solidification rate. Furthermore, the incidence of metal-mould reactions is less.

In alloys having a long freezing range, like tin-bronze and gunmetal, it is extremely difficult to produce castings with uniform properties and free from porosity, even when ideal running and feeding methods are employed, unless the temperature gradients in the solidifying metal are steep and metal-mould reactions are absent. Temperature gradients of the required steepness cannot generally be obtained in ordinary sand castings unless they are of thin section, heavily chilled, or moulded in some kind of material which will cool the casting rapidly. In this latter connection, castings of excellent quality can be produced, using moulds made by the CO_2 process, from silicon-carbide sand bonded with sodium silicate. If such moulds are skin-dried before pouring then metal-mould reactions, due to the presence of water vapour, can be considerably reduced if not entirely eliminated. Research into the development of improved moulding compositions to promote higher level of casting quality is now required to meet the needs of the future.

It must also be appreciated that there is an optimum rate of solidification for obtaining maximum soundness in any particular casting and this is dependent on a number of factors such as design of casting, type of alloy and mould materials employed, pouring temperature, temperature of mould and method of filling the mould. In some cases it is possible to get too rapid solidification which may actually promote shrinkage defects. For example, porosity at the centre of small diameter chill-cast gunmetal sticks is not uncommon.

The improvement in melt-quality to be gained by keeping the hydrogen content in copper-base alloys as low as possible is now conclusively established and one of the best ways of ensuring this is by the use of the coreless electric induction furnace. With the possible advent of cheap electric power, derived from atomic energy, founders of the future will undoubtedly be giving greater attention to the use of electric furnaces for melting purposes. In the U.S.A. the lift-coil high-frequency coreless induction furnace is being increasingly employed by brass-foundries producing quality castings with excellent results. With such a furnace there is no possibility of hydrogen pick-up occurring during the melting operation. Should any hydrogen be present in the raw materials forming the furnace charge this is automatically removed as soon as the metal melts by the oxidizing nature of the furnace atmosphere. The degree of oxidation can be altered at any time by the addition of reducing agents, such as charcoal, and the amount of deoxidants required, such as phosphorus, can be kept to a minimum (0·005 to 0·015 per cent).

The addition of too much phosphorus to gunmetal castings made in ordinary sand moulds can be extremely detrimental, particularly if they have sections over 1 in. in thickness. Many foundrymen do not appreciate the fact that there is need for greater discretion in the use of phosphorus as a deoxidant as the section of the casting increases. If it is desired to promote metal-mould reaction, which is likely to be beneficial only with castings about ½ in. or less in section, the residual phosphorus content should be 0·05 to 0·08 per cent. With castings of heavier section the residual phosphorus content should never exceed 0·02 per cent and this should always be confirmed by routine analysis. Under certain melting conditions it can, with advantage, be less, e.g., when charcoal is used as a melt cover.

Control of Casting Quality

In order to ensure that the required standard of casting quality is consistently obtained a proper system of quality control is obviously essential and this should begin when the casting is first designed.

Many founders still hesitate to offer suggestions to their customers as to how the design of a particular casting could be modified in order to improve quality. When an enquiry for castings is received, it should be part of routine procedure to obtain the views of those responsible for manufacture as to whether the design submitted is suitable, or whether any modifications are desirable.

When design has been approved, consideration must be given to the best way of making the casting. So very often the responsibility of deciding upon suitable running and feeding methods is left to the foundry or pattern shop foreman. Records are rarely kept of methods which have proved successful in practice although much criticism may arise at times regarding those which have given rise to the production of defective castings. As a result the level of efficiency varies with changes in staff, and from foundry to foundry, and little progress is ever made. Running and feeding methods play such an important part in the production of quality castings that it is time every foundry maintained a systematic record of the methods employed. Such a record could be in the form of a card index system, each card containing a photograph or sketch of the methods employed with a note as to the results obtained. Over a period of years a record of this kind would prove invaluable.

It is quite impossible to cover the whole subject of quality control here, and for further information reference should be made to the Symposium on "Metallurgical Aspects of the Control of Quality in Non-Ferrous Castings" arranged by the Institute of Metals in May, 1957.

In connection with the assessment of quality in the finished casting suggested measures are outlined in B.S.1367: 1947—Code of Procedure in Inspection of Copper-Base Alloy Sand Castings and in "A Code of Procedure to Facilitate the Co-ordination of Inspection for Copper-Base Alloy Castings" issued by the Association of Bronze and Brass Founders. These codes of inspection outline procedures which will give the maximum possible information on the properties of sand castings with reasonable expenditure of materials, time and labour.

Hall-marking Quality Castings

Finally, it will be necessary for the British Standards Institution, or the Association of Bronze and Brass

Founders, to introduce a scheme for the hall-marking of castings to ensure that the required standard of quality is being obtained.

Alternatively consideration could be given to the introduction of a system for certifying approved foundries, capable of producing such castings, along similar lines to that now being developed in France by means of the "Quality Label." The Quality Label is an index of the capacity of a particular industrial concern to produce a manufactured product according to an approved mode of manufacture and acceptable standard of inspection. It is applied to the manufacturing unit that produces the product and not to the product itself. However, in order that the label may carry some commercial advantage, the foundry awarded the label is authorized to show the Quality Label sign on its letterheads, invoices, etc., and it may also be applied to the castings if their shape and size allows.

The "Quality Label" system has been adopted by 90 per cent of light-alloy and by 25 per cent of iron founders in France. Its use is now being considered by steel founders but its application to the production of copper-base alloy castings is as yet unknown. French sponsors of the "Quality Label" are even endeavouring to persuade the Committee of European Foundry Associations to consider the introduction of a European Quality Label. In view of these developments it is vitally important that British founders give immediate consideration to the introduction of a similar scheme in this country if they want to maintain their business and their standing in the industry.

There are many advantages arising from the production of castings of guaranteed quality. So far as the founder is concerned quality castings can be sold at a premium with less competition and price cutting as is all too common at the moment. Goodwill will be strengthened and the volume of business increased.

The user of such castings will obtain the benefits of cheaper production costs due to less effort being wasted in machining castings which ultimately prove defective. Properly designed quality castings will be of minimum weight and the customer inspection costs will be reduced.

It is along these lines that the founder and the engineer must work together to meet the needs of the future.

References

1 "Sign of the Times," *Foundry Trade Journal*, 1958, **105**, 2199, 695.

2 F. Hudson, D. R. Wood and J. F. Gregg; *The British Foundryman*, 1958, **51**, 10, 469.

IMPROVING PRODUCTIVITY WITH HIGHER QUALITY AND GREATER ECONOMY

Modern Melting of Non-Ferrous Alloys

By F. M. BUNBURY, B.Sc. and S. J. ROGERS

IN Britain the foundry industry is an old established one, but it grew, particularly on the non-ferrous side, as a very large number of small family concerns, many of which have been very conservative in outlook. Established methods were handed down from father to son, and up to very recent times, there existed an open hostility to new ideas, processes and techniques. The pressure of world-wide competition and industrial expansion has altered this apathetic attitude; the emphasis has changed from craftsmanship to greater productivity with better working conditions, higher metallurgical quality, automation and more detailed cost analysis. In this article the authors propose to outline briefly some of the modern melting techniques which have been adopted in non-ferrous foundries and especially those producing aluminium and copper based alloy castings.

A supply of molten alloy of acceptable quality is the fundamental need of the non-ferrous founder; it is logical, therefore, to begin this survey of modern practices with contemporary trends in metal melting.

Fuel Economy

Furnace design and development are largely governed by price and availability of fuels and, in the United Kingdom where coal has been plentiful, its by-products, coke and gas, have featured predominantly as fuels for the melting of non-ferrous metals. Coke-fired pit furnaces, generally supplemented with a forced draught boost, are understandably popular with the small jobbing founder and such furnaces can be home-made at nominal costs with acceptable performance to melt any non-ferrous alloy. While coke is available at an economic figure it is likely to retain its position as a very convenient fuel in the small jobbing foundry but, with the rapid expansion of the non-ferrous wrought and foundry industries, the exacting specifications of new alloys and the continuous demand for increased production, the coke-fired furnace has revealed its limitations and recent years have seen a steady decline in its use. Several factors are responsible for this; the increasing cost of coke, its poorer quality, its high transport costs, the relative inefficiency of solid fuel furnaces and the tremendous increase in oil production throughout the world. These and other factors have increased the interest in furnaces operating on "piped" fuel, which have proved to be attractive melting units because of accurate control of temperature, low maintenance cost and simple operation without the skill required for firing coke furnaces. It is also of interest to observe, that furnaces designed for burning fuel oil are easily and quickly adapted for gas and the use of any "piped" fuel offers a means of adjusting the furnace atmosphere by judicial metering of the fuel-air control. The modern foundryman, with his increasing regard for technical control, appreciates this facility because metal quality and melting economy can be compromised to best advantage. To give some common examples: the oxidizing requirements of gunmetals and bronze alloys are easily achieved with a high air to fuel ratio and, conversely, reducing conditions necessary for melting copper are obtained with a low ratio. Furnace atmospheres in solid fuel furnaces are much less controllable.

A recent development in the North American continent is the widespread use of natural methane gas which is piped for hundreds of miles for domestic and industrial purposes. Experiments in the importation of this product into Great Britain in liquid form by insulated tankers are being watched with interest and in some industries it could become a serious rival to fuel oil. The foundryman with a piped-fuel furnace will always be in the enviable and unique position of being able to adapt his plant to the most economical liquid or gaseous fuel available; this factor was appreciated by many during the recent Suez crisis.

Thus, the piped-fuel furnace has become firmly established but many foundries have not ignored the possibilities of electricity for economical melting and furnaces such as the mains frequency induction, the resistor and the carbon arc are also widely employed in many modern non-ferrous industries, where their cleanliness of operation and absence of fuel atmosphere ensure top quality melts with low melting losses, a minimum amount of gas absorption and little oxidation.

However, these furnaces are usually complementary to the piped-fuel furnace since their use is only fully justified by round-the-clock operation in order to achieve comparable melting economy. Additionally, their relatively large capital cost is a deterrent to their acceptance by the smaller operator.

Melting Efficiency

The relative costs of operating crucible and low frequency induction furnaces for melting aluminium alloys have been compared by F. C. Evans. He has shown that the average crucible furnace in use in foundries today operates with an efficiency of less than 20 per cent, whether fired by coke, gas or oil; oil-fired reverberatory types have an efficiency of under 35 per cent; electric furnaces, on the other hand, can be as high as 83 per cent efficient, showing the overwhelming advantages of electric melting if the furnaces are operated continuously. Most non-ferrous foundries in Britain are relatively small, melt a large range of alloys and cannot afford or maintain electric furnaces but it is of interest that, in America today, the greater part of the brass and gunmetal foundry output is from rocking arc furnaces, while the wrought industry almost exclusively uses induction melting. Whether cheap electricity will ever become a reality with the expansion of atomically-generated supplies remains to be seen but, unless this is so, widespread change-over to electric melting cannot be foreseen in the immediate future.

With the exception of the electric furnace, the fuel burning unit can adversely affect the quality of a melt by the presence of incompletely burned gases and the products of combustion which can be absorbed by the molten metal. The most undesirable result of combustion under reducing conditions is excessive absorption of hydrogen, a principal cause of gassy metal; on the other hand, oxidizing conditions can lead to excessive metal losses due to continual oxidation of the melt surface. Understandably the furnace designer strives to obtain the highest thermal efficiency so that operating costs are low, but, in doing so, he may neglect to pay adequate attention to furnace atmosphere. The direct heating furnaces such as the rotary and static reverberatory are recognized by the producers of ingot as very efficient units, but, at the same time, metal loss through oxidation or gassy melts arising from incorrect furnace atmosphere can be considerably higher than in crucible types. Fortunately, however, the shortcomings of the fuel burning furnace are not insurmountable; the modern development of melting fluxes has led to a surprisingly high level of understanding of basic melting chemistry, and, for the majority of commercially produced non-ferrous alloys, specially compounded fluxes, simple in application, have been evolved which achieve a consistent standard of melt quality and low melting losses in all types of melting unit. Thus, currently, the choice of furnace ultimately depends on relative melting efficiency coupled with cost of installation.

Temperature Control

In the modern concept of melting all metals and alloys the strict control of temperature is absolutely essential, not only to avoid excessive gas absorption, oxide formation or loss of alloying elements, but also to ensure that castings are poured at the optimum temperature to produce satisfactory running and cooling conditions. The principal instruments used by foundrymen for this purpose are base metal thermocouples, rare-metal thermocouples and radiation or optical pyrometers; if correctly adjusted all instruments can record temperature with an accuracy of at least plus or minus 1 per cent[2]. Recent developments in protective sheaths for thermocouples have overcome many of the original difficulties which plagued users of such instruments a few years ago and, in the melting of non-ferrous metals, silica or graphite sheaths are now available which will withstand about 100 immersions. However, continuous temperature measurement of liquid non-ferrous metals is difficult owing to the relatively short life of these protective sheaths. High duty irons are widely used for this purpose and several new materials are currently being investigated, but Land[2] has pointed out that this problem is worthy of more serious research because up to the present time no thoroughly reliable thermocouple sheath has been found for continuous immersion in liquid metals.

Automatic temperature control is not new but it is becoming much more widespread and reliable as methods of continuous adjustment of the heat supply are displacing the old "on-off" methods. The simplest method of controlling temperature is to turn off the heat when the metal gets too hot and then to turn the heat on again when the temperature drops below some pre-determined minimum. This process inevitably results in cyclic variations of temperature above and below the desired value because it may be some moments after the heat is turned on or off that the intended result is transmitted to the bath of liquid metal. Better control is obtained if the heat is continuously adjusted and, thus, automatic variation of fuel flow is more desirable than on-off systems.

Controlling Metal Losses

At the beginning of this century the brass founder worried little about metal losses; his alloys were simple ones without important minor constituents to be kept within close tolerances, costing systems were virtually non-existent, zinc losses were substantial (if the high incidence of zinc poisoning is any criterion) and local authorities turned a blind eye to the vast clouds of fume poured over the country. The developments in the metal industry which have taken place since that time have evolved alloys to meet almost every engineering requirement and have made the light alloys of magnesium and aluminium so readily available that a vast new industry has grown up within the old-established non-ferrous foundry trade. Foundry science has been forced to keep pace with industry's need for higher quality and productivity at lower cost so obviously there is now a much more urgent need for using raw material in the most efficient way.

Recently several investigators have made statistical surveys of melting losses in the industry, where previously such information was unavailable because foundrymen were not equipped to assess such losses accurately. Jackson and Brown[3] have found losses of up to 4 per cent with crucible melting of brass, gunmetal and bronze in the average foundry of the present day, Hanson and Pell-Walpole[4] quote losses of up to 4 per cent in the reverberatory furnaces, and Cook[5] has shown that electric induction melting of yellow brass can be expected to produce a loss of 2 per cent. Assuming that these losses average 2 per cent throughout the industry and that zinc represents half of them, one realizes that there is an annual national loss in Great Britain of over 1,000 tons of this metal alone in foundries at the present rate of production of copper-base castings. Such a substantial figure cannot be overlooked and is of national, as well as individual importance. Rice[6] has stated that an impressive performance by a furnace, as regards fuel consumption, maintenance, crucible attack and labour involved, may be more than nullified by a high melting loss. Additionally, minor alloying elements play such an important part in achieving the high physical properties of most engineering alloys in use today that the loss of these elements through careless melting can result in failure of castings to meet the specifications demanded of them and, consequently, in a resultant fall-off in productivity. For instance, the zinc alloy generally used in the production of pressure die-castings contains 0·04 per cent of magnesium; if this magnesium is lost through over-heating of the alloy or other causes, pressure die-castings can suffer from severe sub-surface network corrosion.[7]

Melting losses have been reduced to the figures quoted above largely through the efforts of flux manufacturers who have developed covering fluxes especially for individual alloys and melting units. It is a common belief that melting losses of copper-base alloys are highest with furnaces of the forced draught type, such as reverberatory and rotary, but, if the correct type of flux is used, there is no evidence that melting losses with these furnaces need exceed the losses obtained with crucible melting. Electric furnaces, even without fluxes, show a melting

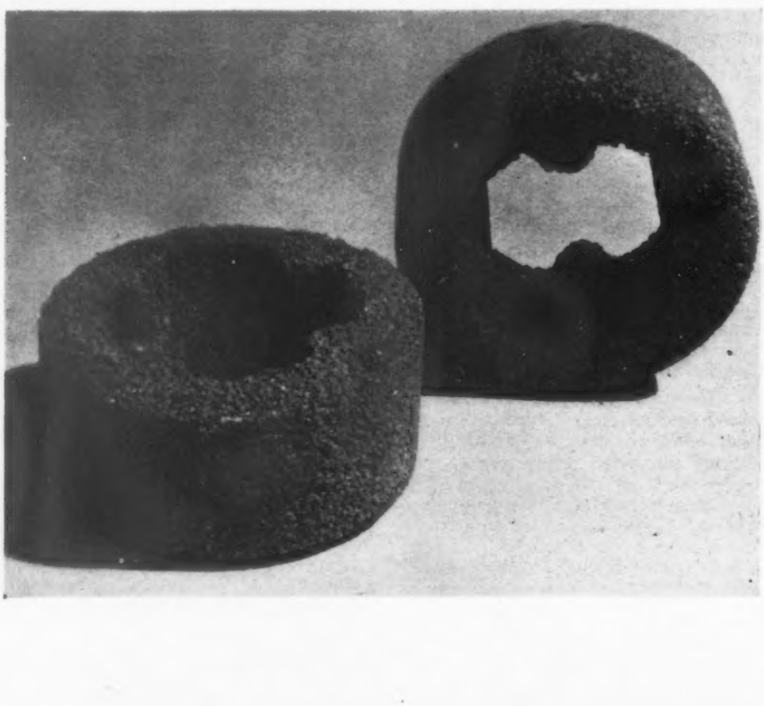
loss as low as that attained by the best crucible practice and Duckett[8] has shown that, even when melting high-leaded brass scrap in Ajax Wyatt low frequency induction furnaces, losses can be kept to less than 2 per cent by using a liquid flux followed by the treatment of the slag with an exothermic drossing-off flux just before pouring. Jackson and Brown[3] reduced net melting losses to the impressive figures of 0·4 and 0·3 per cent by using proprietary fluxes on 400 lb. melts of 65/35 and H.T. brass in a crucible tilting furnace. Charcoal is often used as a protective cover for brass melting but, since brasses contain 30–40 per cent of zinc, these alloys boil at temperatures ranging from 1,140°C.-1,070°C. and it can be appreciated that there is a steady escape of zinc vapour from an exposed surface or through the permeable layer of charcoal although the charcoal may appear to be preventing the formation of zinc oxide. This volatilization of zinc and the preferential loss of other elements can be markedly reduced by the use of protective fluid fluxes during the melting operation and it is through the use of such fluxes that melting losses as low as 0·1-0·2 per cent have been achieved. Furthermore, modern melting fluxes are of such composition that there is little decrease in the normal life of crucibles or furnace linings.

Aluminium alloys and certain copper-base alloys containing aluminium, such as aluminium bronze, do not suffer from high melting losses even without a flux; this is probably due to the formation of a film of alumina on the surface that reduces the loss of other elements by oxidation or volatilization, as is supported by the fact that loss of zinc from ordinary brass is greatly reduced by very small additions of aluminium, as quoted by Murphy.[9] However, Brown[3] found that fluid fluoride fluxes, designed to remove alumina which could reappear as inclusions or films in the solidified casting, kept net losses to well below 0·5 per cent in 400 lb. crucible melts of high tensile brass.

It has been shown that liquid fluxes can greatly reduce the loss through volatilization during the melting period but fluxes of high fluidity, if they do not thicken during the melting process, must be thickened by the addition of an inspissator if they are to be skimmed cleanly from the metal before pouring. This increased viscosity, although facilitating skimming, unfortunately has a serious disadvantage; the sticky nature of the viscous flux traps small globules of molten metal which are unable to flow through the flux and return to the melt. It is common practice to recharge such skimmings into the furnace in a subsequent melt or to treat them while they are still hot with an exothermic flux which produces sufficient heat to increase the fluidity of the slag and to remelt the entrapped globules of metal to such an extent that they coagulate and flow freely to the base of the receptacle.

Zinc die-casting alloys are generally melted without a flux cover; the low temperatures involved are insufficient to cause zinc loss through volatilization. However, the surface of the metal oxidizes rapidly and the die-casting operator is forced to remove the oxide scum, which can contain up to 90 per cent metallics, at regular intervals. Numerous proprietary fluxes have been developed for subsequent recovery of metal from such accumulations of dross and many of these are effective in recovering well over 75 per cent metallics but, as these fluxes either contain chlorides or substantially increase the metal temperature through their exothermic action, loss of important constituents such as magnesium can reduce the properties of the alloy below the specifications demanded and some replacement of the minor alloying constituent is usually necessary.

Fig. 1—Degassing briquettes for copper-base alloys



Control of Hydrogen Content

Although high melting losses are a direct result of inefficient melting, they do not always affect the quality of the foundry's output and generally are more evident in the annual balance sheet but inefficient melting can also produce one of the most prevalent causes of defective castings, namely gas porosity due to hydrogen.

This problem of gas control in molten non-ferrous metals has received much attention from investigators everywhere in recent years which emphasizes the fact that gas absorption is one of the major factors responsible for the failure of castings. Bailey and Baker[10] gave the following reasons for gas porosity in a casting, which are related to the melting process.

(a) The rejection from solution of an elementary gas when the metal solidifies. This is due to the much higher solubility of the gas in the molten state than in the solid. The gas removed is invariably hydrogen, its solubility increasing with the temperature of the melt until a point is reached where the vapour pressure of the metal rises sharply towards its boiling point and hydrogen solubility drops accordingly.

(b) The second type of gas formation is where a compound gas is liberated on solidification by the reaction of two constituents, both of which are soluble in the molten metal but at least one of which is less soluble in the solid metal. The classic example of this type is the case of hydrogen and oxygen in copper, where the hydrogen and oxygen form steam during solidification and so produce unsoundness in the cast product. This will be discussed at greater length later in this article.

The presence of hydrogen gas in molten non-ferrous metals is attributable to several factors, many of which can be avoided by careful selection of raw materials: (a) Corroded ingot and scrap which contains hydrogen corrosion products; (b) electrolytically-reduced metals (such as cathode copper) which may contain absorbed hydrogen; (c) oily scrap; (d) moisture in the products of fuel combustion which decompose on heating to give hydrogen; (e) moisture on tools, fluxes, turnings, etc.

Many of these influential factors can be easily avoided by good housekeeping but the part which the furnace atmosphere plays in controlling the gas content cannot be over-emphasized. In both crucible and reverberatory furnaces, irrespective of whether gas, oil or solid fuels are used, a reducing atmosphere will favour hydrogen absorption and a slightly oxidizing

TABLE I—PROPERTIES OF COPPER-BASE ALLOYS AFTER DEGASSING

Alloy	Chemical Composition								U.T.S. tons/in²	Elongation per cent on 2 in.	Density gm/cc
	Cu	Sn	Zn	Pb	Ni	Al	Fe	P			
Leaded Bronze, Untreated	86·82	9·06	Nil	3·74	0·28	0·01	0·02	0·01	15·4	14	8·82
Leaded Bronze, Treated	86·50	9·18	Nil	3·94	0·27	0·01	0·02	0·01	17·9	18	8·92
Gunmetal, Untreated	86·24	4·68	3·10	5·54	0·30	0·01	0·02	0·02	12	13	8·73
Gunmetal, Treated	85·38	4·92	3·10	6·20	0·25	0·01	0·02	0·02	16·3	17	8·89
Phosphor Bronze, Untreated	88·40	10·8	Nil	0·13	0·01	trace	0·02	0·59	12·3	7	8·17
Phosphor Bronze, Treated	88·62	10·5	Nil	0·13	0·01	trace	0·02	0·60	14·2	11	8·36

atmosphere is desirable. These precautions alone cannot guarantee gas-free metal and, even in electric furnaces where the furnace atmosphere is less influential some treatment to ensure hydrogen expulsion is essential.

Technique for Aluminium Alloys. One method is by flushing with scavenging gases, and, in aluminium alloys, the removal of hydrogen gas from the molten metal by this method has been standard practice for many years. The concentration of a dissolved gas in a liquid metal is directly proportional to the square root of the partial pressure of that gas in the atmosphere in contact with the metal. Thus, it follows that gas removal from a melt will occur if gassy metal is brought into contact with an atmosphere free of the dissolved gas, but from the practical aspect, such a process is extremely slow. This slow removal of gas is apparent when a gassy melt of an aluminium alloy is held at an even temperature for a lengthy period with an oxide-dissolving flux cover; the hydrogen dissolved in the metal gradually diffuses into the atmosphere above it. To speed up this gas removal, it is advantageous to introduce the scavenging atmosphere into the melt in the form of fine bubbles; this technique is now the accepted method of degassing various alloys. The scavenging gas is generally chlorine, nitrogen or aluminium chloride produced by the decomposition of solid chlorinated hydrocarbons marketed as tablets.

Ransley and Neufeld[11] have shown that large volumes of scavenging gas are necessary to reduce the gas content of a melt to very low values and it follows that a given volume of scavenging gas will be more effective if it is bubbled through the melt as a very large number of minute bubbles rather than as relatively few large bubbles. A recent development in the design and composition of solid chemical degassing tablets has achieved this effect to a degree not possible with the original types; the latter were plunged into the molten metal by means of a bell-type plunger, whereas the modern tablet is of annular design which can be slipped over a bent rod to facilitate plunging and thus evolves a free flow of very fine bubbles.

Techniques for Copper-base Alloys. With copper-base alloys, hydrogen gas is controlled by either, or both, of the two available current techniques; oxidation-reduction melting and the use of scavenging gases. The oxidation-reduction technique, which is now an accepted practice throughout the world for the melting of tin bronzes and gunmetals, will be discussed later in this article but, briefly, by such a technique the hydrogen content of a melt is kept well below its solid solubility by maintaining oxidizing conditions and later all traces of oxygen are eliminated by adequate deoxidation. In more recent years it has been found that this technique can also be very satisfactorily applied to phosphor bronze alloys where it was once considered that such oxidizing fluxes would steadily reduce the phosphorus content of the alloy before effecting any hydrogen removal. However, in contrast to this theoretical prediction, hydrogen elimination is successful and the loss of phosphorus is comparatively slight. The reason for this, and also the comparatively small loss of zinc, lead and tin from copper alloys when using oxidizing fluxes, is probably due to the fact that hydrogen diffuses much more rapidly to the surface of the melt to combine with the oxidizing agents in the flux than do any of the alloying elements.

For removal of hydrogen by the flushing technique, the scavenging gas generally employed with copper-base alloys is nitrogen and Baker and Child[12] carried out an extensive investigation on molten bronzes and gunmetals to assess its efficiency. The process has disadvantages; severe turbulence can result in a high loss of zinc, the equipment required is cumbersome and the use of relatively fragile tubes to introduce the gas presents an additional cost not to be overlooked. Recent developments of a solid annular degassing briquette (Fig. 1) which effectively evolves the scavenging gas in a manner somewhat similar to the proprietary products already described for degassing aluminium, are now arousing considerable interest. The beneficial effects of such degassing treatments on the physical properties of copper alloy melts have been emphasized by Cooksey[13]; the examples quoted in Table I are results obtained with this new degassing medium and it is of interest to note that the alloy compositions remain relatively unaltered. Current developments of this technique will undoubtedly be watched with interest by producers of high conductivity copper and aluminium bronze castings where oxidation/deoxidation melting is not acceptable as a means of controlling hydrogen content.

References

1 F. C. Evans; *Met. Ind.*, 1951, **78** (6), 103.
2 T. Land; *Metallurgical Reviews*, 1956, **1**.
3 R. S. Jackson and W. D. Brown; *British Foundryman*, 1957, **1** (3).
4 D. Hanson and W. T. Pell-Walpole; "Chill Cast Tin Bronze".
5 M. Cook; *J. Inst. Met.*, 1935, **57**, 53.
6 J. L. Rice; B.N.F.M.R.A. Report No. 58, 1957.
7 E. Anderson and G. Wesley; "Zamak Alloys for Zinc Diecasters."
8 R. G. Duckett; Private communication to the authors.
9 A. J. Murphy; "Non-Ferrous Foundry Metallurgy." Pergamon Press.
10 W. Baker and D. Bailey; *J. Inst Met.*, 1949, **75**, 292.
11 C. Ransley and H. Neufeld; *J. Inst. Met.*, 1948, **74**, 599.
12 W. Baker and C. Child; *J. Inst. Met.*, 1944, **70**, 349 and 557.
13 R. J. Cooksey; Foseco Foundry Developments, Vol. VI to be published 1959.

(*To be concluded*)

Safety in Galvanizing

WRITTEN for the Productivity Service of the Hot Dip Galvanizers Association, a handbook, "General Galvanizing: A Manual of Good Housekeeping and Safety," is the third in a series of manuals on factors in galvanizing.

After showing the benefits, both humanitarian and economic, the book illustrates how management can play its part in introducing a programme for maintaining an orderly works. Accidents are analysed and suggestions put forward for preventing them and safety clothing and equipment for galvanizing and maintenance staff are described. The book concludes with chapters on Safety and the Law, and on the effect of the Factories Act on the galvanizing industry. The contents are of interest to galvanizers everywhere and arrangements for distribution abroad are being made through national galvanizing associations in many countries. It is a handy reference book for the galvanizing foreman and supervisor.

Priced at 25/- it is available from the Zinc Development Association, 34 Berkeley Square, London, W.1.

BIRMINGHAM EXHIBITION OF REQUISITES FOR FOUNDRY INDUSTRY

British Foundry Equipment

FOR the first time in these post-war years, an exhibition devoted entirely to the interests of the British foundry industry opened yesterday (May 21) at the Bingley Hall, Birmingham, and will remain open until May 30. The exhibition is sponsored by the Foundry Trades' Equipment and Supplies Association, and some 100 firms specializing in the manufacture and supply of foundry requisites are taking part, displaying their latest products and providing many working exhibits. Special measures have been taken to enable furnaces to be used and molten metal to be handled during the run of the exhibition.

An interesting feature is the stand of the National Foundry Craft Training Centre, which shows the work done at the Centre, with moulds and castings actually being made. A series of visits to the exhibition has been arranged for the various branches of the Institute of British Foundrymen. The exhibition is not open to the general public, and admission will be by trade card or ticket presented at Bingley Hall between 10 a.m. and 6 p.m. each day, with the exception of Sunday.

We are indebted to the firms concerned for the following brief summary of their exhibits.

Acme Conveyors Ltd.—As a result of a recent agreement with the Ajax Flexible Coupling Company, of U.S.A., Acme become the sole licensees in this country for the manufacture of the American company's vibrating conveyors and screens. This equipment is prominently featured on the stand, the actual units shown being an Ajax 24 ft. vibrating conveyor, and 3 deck Ajax screen illustrating the other uses of the vibrator unit apart from conveying. A screw conveyor, together with a 20 in. troughed inclined belt conveyor, completes the working sand system. A recent development by the company is shown in the "Sand-at-Hand," which was designed with the smaller foundries in view. This can be used with from two to six moulding machines, with further units added for more. On loan specially for the exhibition from the C. C. Bartlett and Snow Co. of U.S.A., is a working model mould conveyor. Acme are the sole licensees for the manufacture of this equipment in this country.

Air Automation.—This exhibit consists of a wide range of pneumatic equipment suitable for incorporation in foundry and other processes. Specially displayed are the following:— core box air vents, brass and steel slotted pattern, and Perflec mesh, packed in fitted boxes of unit quantities; "Pneugrip" air operated vices, of small size and high gripping capacity; "Airmatic" air cylinders, single and double acting, cushioned and non-cushioned, a particular feature being the provision of universal mountings on each cylinder to enable it to be either foot, flange, nose or trunnion mounted; also "Airmatic" air control valves, a new design giving long service without leakage.

Wm. Aske and Co. Ltd—The theme of this exhibit is the exclusive fourfold offer to the foundry industry by the makers of "Baltiseed" sand binders. Each of the four main display panels symbolizes the facilities extended to users of these products by the makers. These include concentrated experience of over half-a-century by specialists engaged on the production of sand binders, up-to-date plant, research and laboratory control, and a full scale technical service specialized for the foundry industry.

The seven main groups of "Baltiseed" products—core oils, cereal binders, emulsion binders, silicate binders, facing materials, synthetic resins and air-setting and quick drying binders—are illustrated by actual examples of work done, by photographs of large cores and castings, and by type samples of the materials used in their production.

August's Limited.—The plant for which this company is responsible may be divided into four sections as follows:—(1)—(a) a return sand belt conveyor with National August Coolevayor (and cyclone) unit for cooling sand; (b) a mixing unit consisting of a 1½F August-Simpson Mix-Muller, bucket loader and aerator—batch capacity 1,000 lb. of sand; (c) an Elevayor which has a dual purpose—to elevate and aerate the sand; and (d) a moulders' helper arranged in conjunction with the Elevayor to provide machine moulders with a continuous supply of mixed sand. (2)—plant for precoating sand with phenolic resins for use in the shell moulding process; (3)—a National August hydrofilter wet dust collector, shown working in conjunction with the Coolevayor (see 1), capacity 4,000 c.f.m., and (4)—a No. 00 size vacuum mix-muller with stainless steel interior; a bottom chamber and crib jacket is incorporated for heating or cooling as required. This is a general purpose machine for use in many industries.

Baker Perkins.—Shown publicly for the first time is the Taccone diaphragm moulding machine, a unit which, the company states, makes really automatic moulding available for every foundry and is suitable for high production or jobbing work. Also on the stand are Castmatic die-casting machines, manufactured under licence from the Italian firm of A. Triulzi. These machines are available from 90 to 1,000 tons locking force. The company is also showing for the first time their new shell moulding machine, which is fully automatic in all its operations, requiring only the sand/resin storage hopper to be kept full. Other products displayed include a full range of shot blast machines, including the Girojet shot blast machine and a portable shot blast machine; a vertical sand mixer, and a mobile sand conditioner.

F. W. Berk and Co. Ltd.—A number of new products are included in the lines shown by this firm. Petro Bond is manufactured by an associated company—Abbey Chemicals Ltd. This product consists mainly of a specially refined and treated clay, resulting in a product which bonds with oil, in a manner similar to the normal bond of clay with water. Because no water is necessary in the sand mix, low permeabilities are permissible and a very fine sand can be used.

Siliflex, Siliflo and Silicol, are all special CO_2 materials made by this company, some under licence from Nobel-Bozel, Paris. They have only recently been placed on the market and preliminary results are stated to be most encouraging. Siliflo is a completely new breakdown additive, based on materials not previously used in the foundry industry. This exhibition is being used to launch Berkoal on to the market. Large scale trials with this material are now being carried out in some selected foundries.

Francis W. Birkett and Sons Ltd.—On this stand are shown the range of Franber Rhodius depressed centre high-speed grinding discs and abrasive cutting-off wheels. These abrasive discs and wheels are manufactured in many grades for the cutting and grinding of most metals, and also for stone, plastics, concrete, tiles, etc. A special feature of these items is that, due to their particular method of construction, they are practically unbreakable.

Birlec-Efco (Melting) Ltd.—This newly-formed company is displaying two working furnaces. One is a self-contained high frequency induction melting unit. The other is a holding furnace for the automatic pouring of molten aluminium and zinc-based alloys. Power for the former is provided by a 15 kW "power pack" which can be used for melting and induction heating operations such as hardening, annealing, sintering, brazing, pre-heating, hot-forming, and vacuum heating processes. At this exhibition, the unit is used in conjunction with a melting furnace, and small castings in steel and iron will be made. This unit is of the motor alternator type and, therefore, of simple and reliable construction. The cubicle enclosed unit requires no further installation than placing in a suitable position and connection up of the incoming power lines and water cooling pipes.

A demonstration of a working unit of the Birlec Ajaxomatic furnace with E.M.B. diecasting machinery is being given. A holding unit for pouring molten aluminium and zinc-based alloys, its swift automatic operation enables the rate of die-casting production to be raised considerably. The Ajaxomatic is said to be simple in operation for once the timing dials are set, an exactly measured quantity of molten metal is delivered to the machine simply by pressing a button. This unit is rated at 20 kW with a molten capacity of 300 lb. and an average power consumption of 10-12 kW. Also on show is a working model of a Detroit Rocking Arc furnace.

E. Boydell and Co. Ltd.—A highly mobile hydraulically-operated front-end Muir-Hill LH1 Loader, which has a wide variety of foundry applications, is being shown by this Manchester company. Stated to be ideally suited to confined operating conditions, this machine has an overall width of 4 ft. 3 in., a turning circle of 15 ft. and requires a working head-room of only 6 ft. 6 in. It can manoeuvre in restricted spaces previously accessible only to hand labour.

British Foundry Units Ltd.—On this stand is displayed the company's general range of foundry productions including the following: — Crulin core binding materials; binders for the CO_2 process; Silverskin spirit blackings; special fluxes for non-ferrous metals, aluminium, etc.; Puric cupola flux. As a new departure, the company is showing a range of ceramic strainer cores in a variety of sizes, a section of their business which is being rapidly and extensively developed. Their range of foundry machinery shown includes the Vortec range of core sand mixers, blacking mixers and sand throwers, also the Anson shell moulding equipment, which consists of the Anson shell moulding machine, and the Anson shell core blower.

British Industrial Sand Ltd.—This company is showing a full range of washed and silica sands for the foundry industry, produced at the company's quarries at Redhill, Surrey; Kings Lynn, Norfolk; and Castleton, Yorkshire. Feslente Limited—a wholly-owned subsidiary—displays their range of resin-coated sands and will demonstrate the mass production of shell cores, using a grade of Feslente sand specially developed for this purpose.

Both companies also exhibit samples of cores, moulds and castings made from B.I.S. and Feslente sands. Demonstrations of sand testing, using the type of equipment normally employed in the company's foundry sand laboratory, Redhill, are given at any time during the exhibition.

British Moulding Machine Co. Ltd.—Because of the increasing interest in automatic moulding, most of this stand is given over to the operation of a pair of type B.Q. automatic machines working with 22 in. × 16 in. × 7 in. box-parts. The machines are fed with sand from overhead hoppers and this section of the exhibit really amounts to a miniature mechanized foundry complete with closing, shake-out, sand elevator and box return, etc. Of particular interest will be a fully automatic device for turning over the drag half of the mould and putting it on to a conveyor ready for coring and closing. This unit will normally be operated by a crew of two, but it is also demonstrated with only one man making both half moulds and closing. These two machines are of the roll-on roll-off type.

A third type B.Q. machine, also automatic, is engaged upon the simultaneous production of copes and drags in boxes measuring 16 in. × 13 in. × 4 in., the intention being for the operator to core and close two half moulds whilst the machine is automatically making the next two. The only other moulding machine on the stand is a B.T.1 turnover type making drag half moulds in conjunction with "Nomad" palettes and rail type conveyor.

The Carborundum Company Ltd.—This Manchester concern is making a display of super-refractory materials in silicon carbide and fused alumina. These super-refractory materials are made into bricks and special shapes known under the trade names Carbofrax, Refrax and Alfrax and have great refractory value. They are designed to withstand the highest commercial temperatures, resist abrasion and do not spall under rapid changes of temperature. The high thermal conductivity of silicon carbide is effectively used in many applications. The display covers bricks, tiles, kiln furniture, tubes and muffles with a range of high temperature cements.

Crucibles of varying shapes and sizes are shown, these crucibles being designed for use in the non-ferrous metal melting industry.

Catalin Limited.—This company offers a range of resins and resin-based products to meet the many and varied requirements of the foundry industry. Of especial interest is the range of "Cataset" air-setting binders for mould facing and for cores—the result of intensive research and development in this interesting and rapidly expanding field. "Catalac" sprays—both flame and air-setting types—are established lines in regular use in the industry and are worthy of detailed study.

For those engaged in shell-moulding are the alternatives of powder resin or liquid resin for self pre-coating. Of particular importance in this field is the new "Catamold" powder resin which gives vastly improved casting finish. For stoved cores the range of "Catacore" resins offers a choice of product to suit all needs.

The Coleman-Wallwork Co. Ltd.—From this Bedfordshire company come several machines of particular interest to the industry. There is the Shalco shell core blowing machine, producing finished, single or multiple cores, ready for setting in 30/50 sec. The shell cores possess high permeability and strength with good collapsibility. This range is stated to be simple to operate, and fast and efficient in service. Then there is the SSC. Shake-out and sand conditioning unit. This is a heavy duty, fully portable Floatex shake-out, equipped to produce clean sand while shaking out. It incorporates the fully floating principle employed throughout the range of Hewitt-Robins Floatex shake-outs, ensuring that no vibration is transmitted to the foundations. The whole unit comprises a shake-out, screen, conveyor belt, lump breaker and magnetic head pulley, and performs five distinct operations on moulding boxes up to 12,000 lb.

In addition, there is the Electramold moulding machine, an electronically controlled simultaneous shockless jolt squeeze moulding machine designed to meet the increasing demand for automatic units, capable of producing accurate moulds at maximum speeds. The machine demonstrated is the type RL.300, having a useful load of 300 lb. and roller stripping device. This model can also be supplied with a pin lift pattern draw mechanism.

The Constructional Engineering Co. Ltd.—The products of this Birmingham company are shown on two stands, the first of which presents a Cupolette, typifying the cupolas of which over 4,000 are in use. Special attention is focused on the M.B.C. with its hot blast and high degree of metallurgical control. A range of photographs and explanatory diagrams show the company's activities in the handling of foundry raw materials.

An associated company—A. Tagliaferri Industrial Furnaces Ltd.—is also presenting a comprehensive range of photographs showing mains frequency induction melting furnaces as the latest technique of metal melting for the foundry industry.

A further stand displays a complete range of core blowing equipment, moulding machines and sand mixing equipment; a new type of conveyor belt with corrugated flange, capable of handling increased loads is exhibited for the first time. A refractory spray gun suitable for re-lining of cupolas and electric furnaces is shown. The activities of the company in helping foundries conform to the requirements of the Clean Air Act are also demonstrated in excellent illustrations of the range of grit and dust arresters that are working with high efficiency in various plants throughout the country.

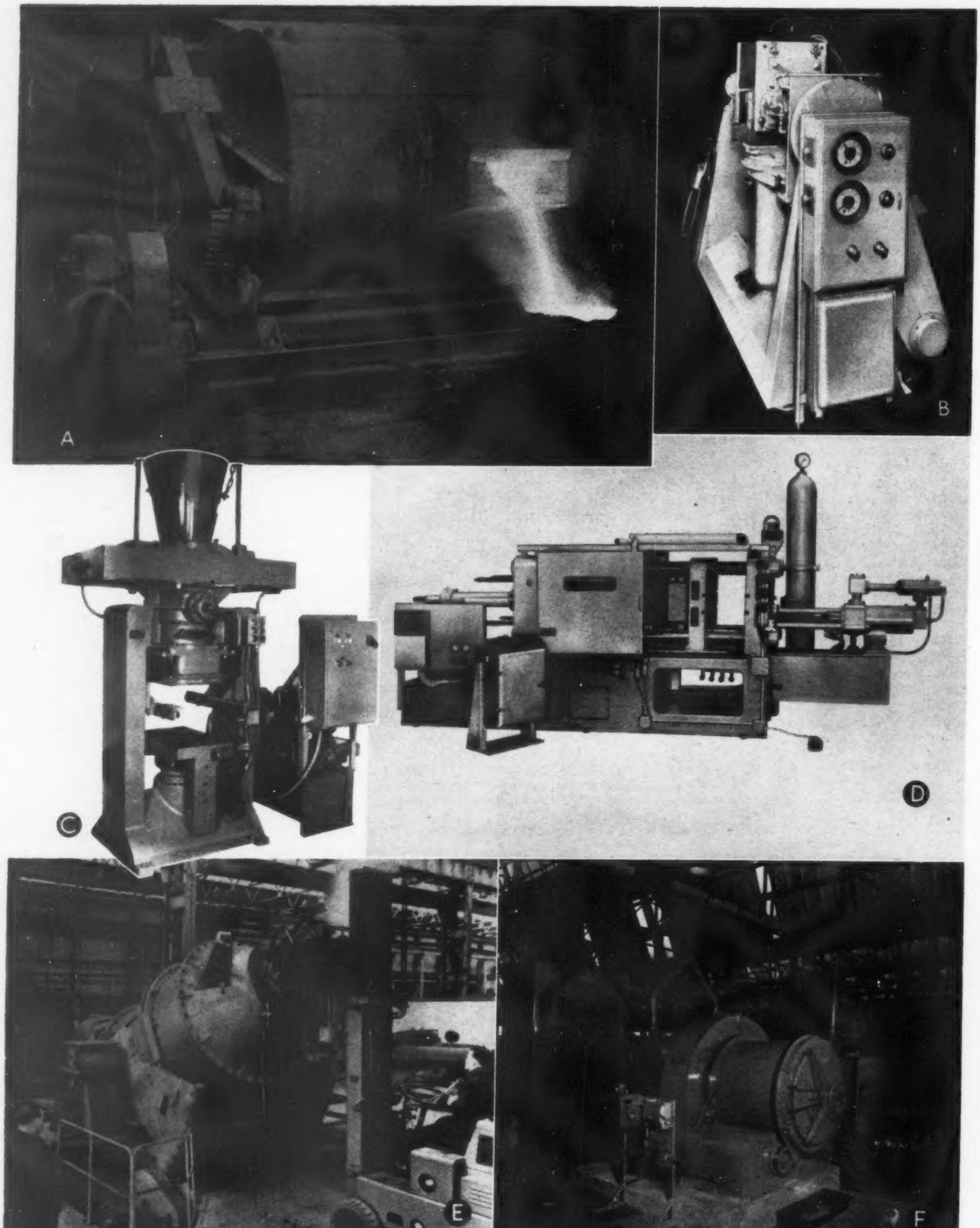
Coreshooters Sales Ltd.—Included in the items exhibited by this company are the following: — The latest oil-pneumatic Hansberg Coreshooter with press-button operation and automatic sand feed; a new type M Hansberg Coreshooter, manually operated by a single control handle and with mechanical setting of the table. This machine includes several novel features of design to give great reliability and easy access to working parts and should appeal to mass-production foundries; a new 2·5 Hansberg Coreshooter, increasing the range of these machines to nine with capacities from 1 to 220 lb. maximum weight per core; the Hansberg H33 vacuum-gas machine for curing cores and moulds with CO_2 or other gases.

The Roperwerk D-1A automatic shooter and hardener which is a three-stage rotary table machine for the mass-production of CO_2 cores up to 8 lb.; the Komax K1A automatic gassing machine for CO_2, being the smaller of two machines available; and, the Roperwerk W2 rollover/core-stripping machine for coreboxes up to 600 lb. weight.

Crockett Lowe Limited.—As pattern makers to British industry, this company exhibits pattern equipment at its very best, created by craftsmen who know every phase of pattern making. Services and facilities offered by this concern include the drawing office—covering layout, design and foundry procedure; a technical consultant service; a wood division, covering pine and mahogany pattern equipment, Keller models and mock-ups; a metal division, covering cast iron, brass, gun-metal, steel and aluminium pattern equipment for loose, machine and shell moulding, match plates, core boxes for use on core blower machines etc., and gravity dies; a pressure cast division and a plastics division.

Dallow Lambert and Co. Ltd.—Dust control equipment for the foundry industry is shown on this stand and includes the following units: — MG 80 type A (heavy duty) wet deduster. The range embraces 13 standard sizes from 2,000 c.f.m. to 48,000 c.f.m. and is available with a choice of four principal methods of sludge removal. Then there is the "Dustmaster" unit dust collector range of which the DM 153 model is displayed. This unit is fitted with standard automatic filter shaking gear, the operation of which is visible through glass panels, the interior of the collector being illuminated. These units are available over an extremely wide range. From a standard range of fans, filters and dust containers, they can be assembled into no less than 120 different sizes of dust collectors for handling the many types of dust problems produced by industrial processes.

The Distillers Company Ltd.—In this exhibition, three members of the D.C.L. group—British Resin Products Ltd., the Carbon Dioxide Department of the Chemical Division, and the Methylating Company Ltd.—are showing their products jointly



A—Metalectric-Calamari mains frequency induction melting furnace. By The Incandescent Heat Co. Ltd.
B—Shalco shell core blowing machine. By Shell Chemical Co. Ltd.
C—Automatic blow squeeze mould making machine. By J. W. Jackman and Co. Ltd.
D—The Peco 40DC5 pressure die-casting machine. By Peco Machinery Sales (Westminster) Ltd.
E—"Monometer" rotary oil-fired furnace. By Monometer Manufacturing Co. Ltd.
F—Airless rotary barrel blast cleaning machine. By Spencer and Halstead Ltd.

on this stand. The greater part of the displays is devoted to the Carbon Dioxide Department's system for the bulk transport, storage and supply of liquid carbon dioxide.

The Methylating Company are exhibiting as suppliers of isopropanol, both as anhydrous materials and as the azeotrope for use in flash dressings. Applied by spray or by brush, these dressings improve the resultant surface quality given by green-sand, cereal- and oil-bonded cores and moulds. Synthetic resins for the shell moulding process are the subject of the British Resin Products section. Marketed under the trade name "Cellobond," these special grades of B.R.P. resins produce shell moulds of high strength with minimum resin content, and give castings with a very high finish. One of these resins has been developed for the cold coating of sand, and is suitable both for shell moulding and for core blowing.

H. J. Dowler (Engineers' Pattern Makers) Ltd.—Among the exhibits to be seen on this Birmingham firm's stand are—(1) a double-sided aluminium pattern plate containing precision brass patterns of heel tips; (2) mahogany pattern of clutch housing; (3) cast iron cylinder head intake bore corebox; (4) cast iron die and samples of die-castings produced from the firm's equipment; (5) Epoxy resin manifold pattern on two single-sided resin plates; (6) Epoxy resin Keller model; (7) Epoxy resin mould for commercial vehicle roof, and also for commercial vehicle cab back.

Electromagnets Ltd.—This exhibit comprises working demonstrations of the Sandsep portable magnetic separating equipment, a flux controlled permanent magnet chute, and a completely new design of magnetic drum separator with vibratory feed, designed for general purpose use, particularly for the reclamation of contaminated swarfs. Static equipment on view includes lifting magnet equipment, a permanent magnetic pulley equipment and a general range of permanent magnet units.

In association with Blending Machine Company Ltd., work demonstrations of a vibratory screen, vibratory feeders and rotary vibrators are also being given.

Fletcher Miller Limited.—On this stand is illustrated the part being played by Fletcher Miller core oils in the improvement of core sand mixing. Many examples of cores bound together by this core oil are displayed, some small, some large, some intricate in shape, others quite simple but all smooth and clean cut. Some of the advantages claimed by the company for the use of its oils include the following: — being concentrated, they are more economical in use, from 0·75 per cent to 1 per cent by weight is said to be normally sufficient for most applications; a long bench life permits mixed sand to be kept ready for immediate use; quick drying, give high dry strengths, less fumes, and have the ability to break down at exactly the right moment.

Fordath Engineering Co. Ltd.—Two new major developments in technique and equipment are emphasized on this stand. (1) The Corovit cold-setting technique of making cores and moulds: foundry sand cores by this process harden in the box or on the pattern ensuring complete freedom from subsequent dimensional distortion. The technique of application, and specimen mould and core assemblies are exhibited.

(2) The central feature of the stand is a complete Fordath No. 250 shell sand coating unit involving coating mixer and elevator, air heater, vibratory screen and product cooling and elevating equipment. This operates as one integral unit, controlled entirely by an automatic cycle timer which ensures the production of technically consistent resin-coated sand. The exhibit also lays emphasis on the Fordath liquid phenolic resins which the firm produces specifically for the coating of foundry sand. Display cabinets and photographs draw attention to the many other basic foundry products of the company such as the Glyso, Permol and Exol corebinders.

Foundry Mechanisations (Baillot) Ltd.—Catering for both the small and large ferrous and non-ferrous foundries, this Bletchley company provides a number of interesting machines on its stand. There is a sand mill (S.B.9), continuous capacity 30 tons/hr., fitted with machine cut spur gear and steel pinion, driven through vertical reduction gear, direct coupled motor. Then there is a sand projection machine, size 6, to which is attached the necessary feeding equipment, which incorporates storage hopper with feeder belt and supporting structure. The prepared sand is supplied by a small unit comprising a 42 in. dia. batch type sand mill fitted with cage type disintegrator, served by a skip loader. The prepared sand is elevated into storage by a 12 in. belt and bucket elevators. This 42 in. mill, although mainly used for facings, is also suitable for core or CO_2 sands. Capacity is between 2-3 tons/hr.

In addition, the company is displaying three mould conveyor plate assemblies with section of track; also a "Felco" jib hoist, 10 cwt. capacity, which services the sand projection machine.

Foundry Plant and Machinery Ltd.—Latest addition to the range of foundry machinery offered by this Scottish firm is the Servo-slinger which is being shown for the first time. This new machine retains the basic principle of the original Sandslinger which the company introduced some forty years ago, but with this difference, the arm movements are effected through the medium of a simple, though ingenious, servo-mechanism. The flexibility of the unit is such that it will ram large and medium size moulding boxes, within the scope of its arms with express speed and to the required mould hardness.

Foundry Services Ltd.—This stand has been designed to resemble a foundry in which all the interrelated activities of foundry work are depicted or demonstrated. Where live demonstration is impossible, working models help to tell the Foseco story. The Foseco organization is concerned primarily with the manufacture and supply of chemical and metallurgical aids to the production of low-cost, high-quality castings.

On the stand, degassing light alloy melts, improving slag viscosity by cupola fluxes and de-oxidizing melts of copper-base alloys for example, are simulated by use of models. In contrast, moulding and the use of mould core dressings are by live demonstrations. Both copper-base and aluminium alloys are being melted on the stand and a 100 lb. capacity Morgan lift-out crucible furnace is being used for melting the copper-base charge and a Sklenar Reverbale junior model melts down the aluminium alloy charge. In the respective cases, there are opportunities to demonstrate a reasonably full range of fluxes for non-ferrous and light alloys.

Visitors can see the making of production die-castings and, on the non-ferrous side, the making of identical castings, one with a "Feedex" exothermic feeder-head and one conventionally fed; one treated with a mould coating and one without any dressing. "Feedex" sleeves and shapes are made up on the stand. Various other Foseco products are being demonstrated, among them the "Porotec" apparatus for the rapid detection of gas in melts of aluminium alloys, the portable hand-mixer, spray guns and the new "Tak" extruder, "Tak" being a new compound for sealing moulds to prevent run-out. Charts, diagrams, a photographic display and models, cover the range of Foseco products for ferrous casting and ingot production, and indicate the international aspect of the group.

Foundry Suppliers Limited.—Among the items being shown on this stand is a comprehensive range of the sand-testing equipment manufactured by George Fischer Ltd., of Switzerland. This precision equipment, adapted to British sand testing specifications, is shown together with two new items — the Overhang test apparatus, for measuring the rigidity of green cores, and the sand-surface test apparatus, which enables measurement of the actual specific surface of a sand, and determination of the so-called "co-efficient of angularity."

Other items shown on this stand include the hygrotester manufactured by Paul Lippke, an electronic development for automatic moisture control of moulding sand; and also the Henschel mixer for precoating sand, the King portable Brinell hardness tester, and the Mullrex Muller, a high quality, inexpensive, mixing and mulling unit of latest design for core and moulding sands.

Fuel and Metallurgical Processes Ltd.—This company supplies hot blast recuperation plants based upon the Vew and Vew Esslingen systems. Many different types of recuperators are available, to work recuperatively or direct oil or gas fired and a working model is on exhibition indicating the fundamental working principles of a recuperative plant. Recuperative systems are available for non-ferrous industries as well as ferrous, and a wide range of furnaces can be adapted for waste heat recovery.

Fuller's Earth Union Ltd.—Fulbond is a high-grade clay bond which is used extensively in British and overseas foundries. The two grades, specially developed to cover every type of foundry practice, are Fulbonds 4-A and 2. Among the special features of the company's exhibit is a model showing typical method of bulk handling Fulbond; a model of a method of adding Fulbond/water to foundry sands by means of prepared slurry; a scale model of the company's research laboratories, indicating the technical resources behind the production of their products; also iron and non-ferrous castings made in Fulbond sands.

F and M Supplies Ltd.—Following the development in core binding materials over the last few years and this company's particular researches into new methods and materials, they are demonstrating on their stand a new development in rapid baking core oil. This oil is stated to be extremely strong and fast baking with standard equipment, but when used in conjunction with equipment that is something new in core shop technique, a very rapid baking cycle can be achieved. In addition, the

company is showing cores made with various other types of core binders for which they are responsible. These cores are loaned by courtesy of some of the many foundries in this country who are using Supinol core binders.

General Refractories Ltd.—One of the principal exhibits on this stand is a comprehensive selection of natural moulding sands, synthetic steel moulding sands, washed and graded and natural silica sands. Examples of cores, shells and castings produced from these sands are shown and photomicrographs and full technical data are available and on display. Specially featured is an electric furnace roof built in G.R. Sillmax material and for larger and basic lined electric furnaces the Ferroclad and "341" Dolomite brick are shown. Of particular interest is a cross-section of a cupola shaft constructed of Glenboig A.1. Scottish firebricks. Basic bricks and ramming material are also exhibited in conjunction with sectional drawings of water-cooled and non-water-cooled basic lined cupolas. Carbon blocks and ramming materials are also shown, as well as linings for desulphurizing ladles.

Representative examples of the wide range of G.R. refractories include the recently developed Ferroclad "EE" brick, containing internal plates to reduce spalling and two new and outstanding fireclay refractories, Glenboig Super Duty and the G.R. blast furnace brick.

Harmark Foundry Supplies.—A display of cores and castings made with the aid of "Harmark" products including the latest developments in fast baking and cold setting core oils is made on this Market Harborough company's stand. Details of a new ultra fast-baking high dry strength core oil—the latest product of their development and research laboratory—are on view with specimen cores for examination. Also represented is a new development in cereal base binders, and examples of CO_2 process bonded cores.

The well established "Harmark" metallurgical products, comprising fluxes, mould and die dressings and a selection of exothermic compounds are shown, and a new pneumatically operated sleeve-making aid—virtually a mechanical core box—is on view, together with a selection of exothermic sleeves produced by it. Its purpose is that of providing a means of producing in the foundry core shop, at a reasonable rate, consistent sleeves of controlled density, complete with sand ring and vent holes.

Harris Engineering Company Ltd.—Visitors to this stand will be able to see the company's range of industrial heating equipment, including the Harris Schwank gas-fired radiant heaters, which are ideally suited for providing adequate warmth for foundry personnel. They are available in a range of sizes which can be fixed at heights varying from 10 ft. to 45 ft. above floor level and give localized warmth wherever it is needed.

The latest addition to the Harris range of dust collecting equipment is a series of unit dust collectors specially designed for use where fettling is being carried out. These units are of the textile fabric sleeve type, fitted with a newly designed shaking mechanism and a drawer at the base to enable the collected abrasive dust particles etc. to be removed with ease. Other Harris products include oil and gas-fired unit air heaters, steam unit heaters and Trion electronic air filters.

W. C. Holmes and Co. Ltd.—Among the exhibits provided by this company is the Holmes-Schneible Multi-Wash system which has been specifically designed to tackle the numerous dust collection and control problems which occur in all types of foundries. Built into this particular unit are three established methods of dust collection as follows:— (a) the tangential entry of the gases into the circular base of the collector utilizes centrifugal force to throw out the heavier particles; (b) the dust particles are bombarded by a finely divided self-induced water spray; (c) the dirty gases pass over large wetted areas.

W. J. Hooker Ltd.—The method of precision investment casting known as "Investril-Plycast" casting is presented by this London company. By this method the cost of mould making, the firm states, can be reduced some 90 per cent, and the time from investment of waxes to casting reduced to an hour or two. In conjunction with this method there are also shown vacuum centrifugal casting machines of completely novel design and conception.

In addition there is a new bale-out furnace shown in conjunction with a new permanent mould gravity die-casting machine, as well as the "Sterling Die Slick" range. Also a general range of foundry supplies, and as sole agents in this country for Badische Maschinenfabrik A.G., Hookers also have an illustrative display of modern developments in foundry lay-out offered by this concern ranging from a single machine to a complete push button automatic foundry.

Imperial Chemical Industries Limited.—The Billingham, Alkali and Heavy Organic Chemicals Division of this company are sharing this stand. This has as its theme "I.C.I. Products and the CO_2/Silicate Process Save Time and Money." The exhibits—sodium silicate, carbon dioxide and isopropyl alcohol—show the many advantages claimed for this process in the production of moulds and cores.

The Incandescent Heat Company Ltd.—For this exhibition the company has focused attention on one piece of equipment, relying on models and photographs to illustrate the many other designs of foundry plant made by the group. The main feature of the stand is a full size independently fired air heater for producing hot blast. This heater, shown on a fabricated platform, is designed to supply blast for two 4-ton per hr. cupolas. The working temperature (500°C) is reached within 30 min. of starting. Heaters already installed have shown remarkable savings: in one case the cost of the installation was recovered in less than 10 months operation. Details of construction are shown by a scale model of the heater with cutaway sections, showing the oil burner and heat exchanger tube bundle. As it would be impracticable to have this blast heater working, live interest is provided by a small Metalectric-Calamari mains frequency induction melting furnace. These furnaces have ratings from 12 to 300 kW, and may be used for melting steel, cast iron, non-ferrous metals and light alloys.

Much of the Group's melting plant is too large for display. It is therefore represented on the stand by two models: a direct-arc melting furnace and a twin cupola installation. Also on display is a model of an Incandescent bogie hearth furnace with Laclede suspended roof, suitable for heat treatment of castings. The Group's other equipment is fully illustrated by colour transparencies and photographs.

J. W. Jackman and Co. Ltd.—This exhibit is intended to show a cross-section of the company's range of foundry plant and shot-blast equipment. Perhaps the most interesting unit shown is the 19M-2 automatic blow squeeze mould making machine. The automatically controlled operating cycle of this machine is novel, exceptionally simple and fast: (1) a flask is pushed in on rollers; (2) under hydraulic power, a piston raises the machine table and flask to a retractable upset, and the mould is blown; (3) the piston continues its movement, taking the mould upwards, and squeeze occurs; (4) the piston descends, the flask is retained on rollers, and draw takes place; and (5) a new flask is entered into the machine, pushing out the completed half mould.

Keith Blackman Limited.—The exhibits on this stand place emphasis on dust removal and extraction, and fume removal. The Hydro Precipitator is for application to foundry knock-outs and sand handling plant. This washer takes in dust-laden air through water film and exhausts clean air to atmosphere. The washer is also suitable for fettling processes, shot-blast cabinets, etc. This unit is a demonstration model, shown for the first time, and is working.

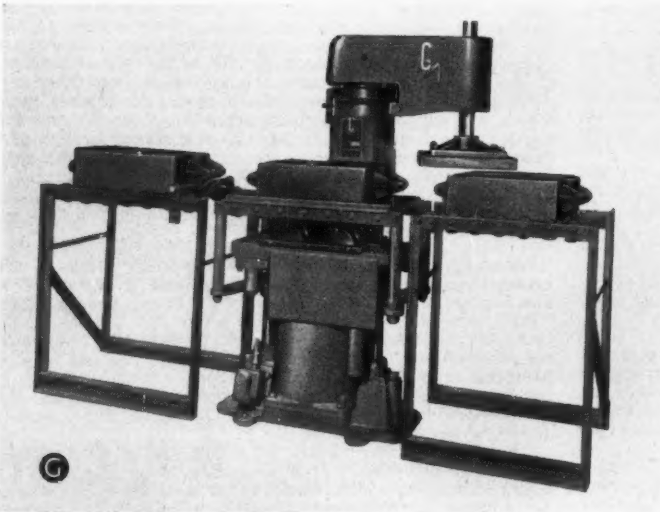
Examples of the "Tornado" range of self-contained dust collection and extraction units are shown; also the bifurcated fan, a direct-driven axial fan, in which the motor is isolated from the airflow by splitting the fan casing to provide a sealed-off compartment for the motor, which is open to atmosphere. The Keith Blackman cupola blowers are represented by a 36 in. type 9 cast iron blower. For general ventilation, a 36 in. APA ring-mounted fan is shown.

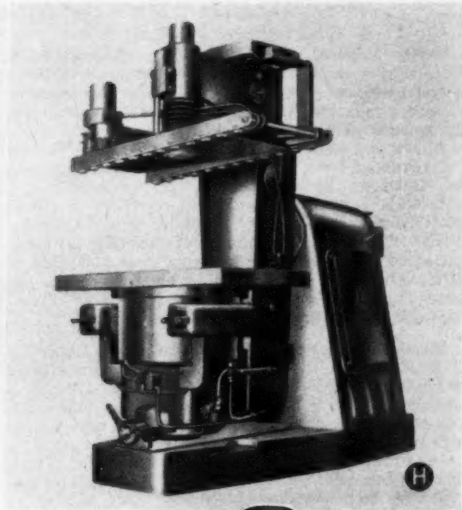
Lafarge Aluminous Cement Co. Ltd.—Manufacturers of Ciment Fondu aluminous cement and Secar 250 white calcium-aluminate cement, this company shows some of the many uses for refractory concrete made with these materials in the foundry and allied trades, including floors, annealing furnaces, melting furnaces, core stoves, cupolas, etc. Furnaces and combustion chambers lined with refractory concrete made with these cements are on view, as well as many complex shapes showing the versatility of refractory concrete.

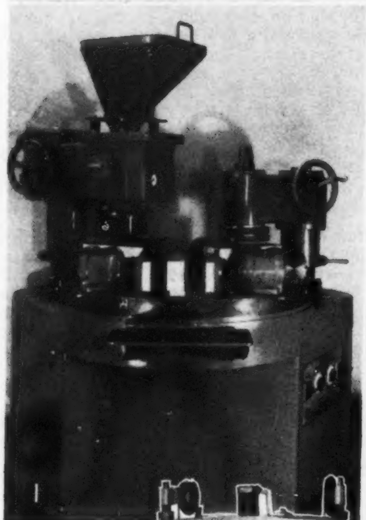
Especially intriguing are the demonstrations of the high thermal shock resistance of refractory concrete. Specimens of refractory concrete, heated to a white heat, are plunged halfway, and then fully, into cold water to demonstrate convincingly the non-spalling properties of refractory concrete. Advice is available in the use of refractory concrete, and visitors are cordially invited to discuss their own refractory problems.

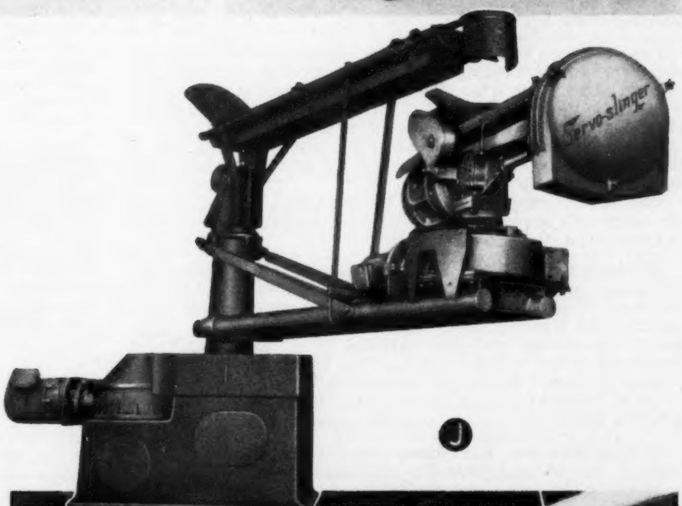
E. S. Lord Limited.—An exceedingly wide range of foundry equipment is represented on this stand. In addition to a 050 Sklenar furnace, there is also a sand mill and a sand mixer on view. Included in the company's products are the "Eagle" brand of core-binders, core oil, core powders, resin binders, and Coldbond for the CO_2 process.

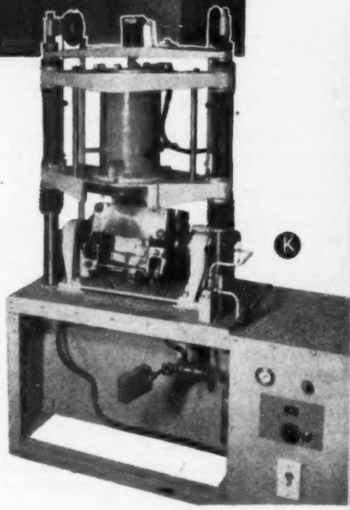
On foundry plant and machinery, this company are northern agents for Sklenar furnaces covering a range from the 050 to the 5 ton melting capacity; also the Reverbale bale-out furnaces, which have a throughput of 300 to 900 lb/hr. of aluminium, and a similar bale-out furnace for yellow brass. The firm is also sole agent for Great Britain of the Zamix core sand mixers, five

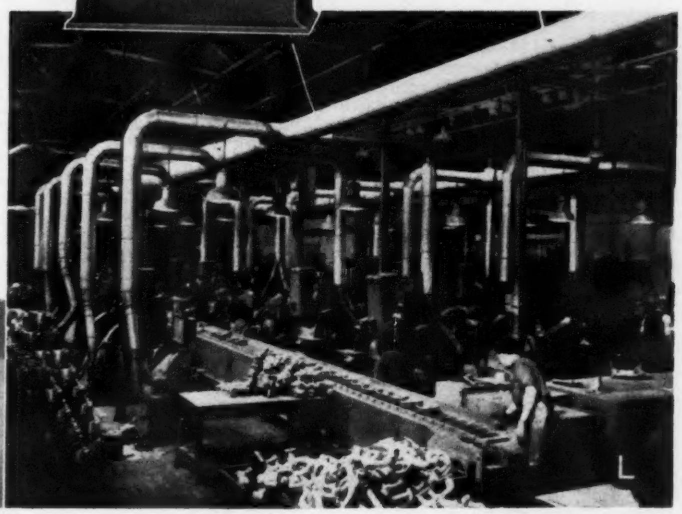












G—Electramold moulding machine shown installed between ingoing and outgoing roller track. By Coleman-Wallwork Co. Ltd.
H—B.T. turnover type moulding machine. By British Moulding Machine Co. Ltd.
I—Automatic coreshooter and hardener. By Coreshooters Sales Ltd.
J—The Servo-slinger. By Foundry Plant and Machinery Ltd.
K—The Anson Mark I core making machine. By British Foundry Units Ltd.
L—Dust collection plant in casting dressing shop. By Dallow Lambert and Co. Ltd.

models of which cover a range of mixing capacities from 17 lb. to 7 cwt.

Mellor Mineral Mills Ltd.—This company is exhibiting a wide range of Dohm foundry products. They include an odourless ignitable mould wash called Dohmspray; Dohmseal refractory glazes; Dohmpatch plastics refractory; graphitic linings, and the new investment base 350 for precision investment casting which appeared on the market recently.

Investment base 350 was developed after extensive tests on the American cristobalite base, and operates at a temperature of 1,450°. It needs no additives, retarders or accelerators, only water to mix into a slurry. Setting time is 20 min.

Also on display is Dohmfrac precoated resin sand and zircon precoated resin sand for shell moulding and shell core production. The sand is available in several grades—depending on metal and application—and is free from clay and other impurities to ensure a flawless surface finish.

Metals and Equipment (Wolverhampton) Ltd.—This company is exhibiting one of the latest types of Zimmermann moulding machines, a turnover device for turning over the moulds, an automatic feeding device for passing the moulds along to the automatic closing device which joins the top and bottom boxes together.

In addition, there are two of the latest type of Vogel + Schemmann core shooters together with illustrations of various types of shot blasting plants and types of shot used for the cleaning of various metals.

The Midland Tar Distillers Ltd.—Inventors and patentees of pelleted foundry pitch, this company provides an interesting exhibit. This pelleted foundry pitch, widely used in the foundry industry, is used in all forms of moulding sand as an ash-free alternative to coal dust, and also in its own right to give bond in dry sand and skin dry moulding practice. This material is also used in some core assembly work and as a breakdown agent in the CO_2 process.

The exhibit comprises various photographs and castings, and the company's specialists are in constant attention on the stand to give advice and help to enquirers.

Mitchells Emery Wheel Co. Ltd.—This display consists of a full range of abrasive wheels and products for foundry use, including 30 in. dia. high-speed snagging wheels, 16 in. dia. high-speed swing frame grinding wheels, 6 in. and 8 in. dia. high-speed wheels for portable grinders, 7 in. dia. high-speed depressed centre wheels, 20 in. and 16 in. dia. high-speed cutting-off wheels, a range of resinoid and vitrified segments, a range of vitrified mounted wheels and points, a range of vitrified grinding wheels for use on portable grinders.

Modern Furnaces and Stoves Ltd.—Three completely new items of foundry equipment are being shown by this Birmingham company. The first is a combined rotary sand dryer and cooler which is a development of the firm's "Newstad" rotary sand dryer. This unit consists of a rotating drum which can be either gas- or oil-fired. Wet sand is fed into a hopper, from which it is delivered into the drying section of the drum; afterwards it enters the cooling end, where it cascades through a stream of cold air and is finally discharged from the dryer at approximately 90°F. Fuel consumption is 1·3 gallons of oil or 500 ft^3 of gas per ton of sand dried.

Then there is an electric portable mould dryer. The all-British "Newstad" hot air unit is self-contained, with its own contactor panel attached to the main casing and fully protected against overheating of the elements by means of a Pyro-Limit indicating controller, and a constant supply of hot air is provided by a powerful fan integral with the unit. For transportation by crane, substantial lifting lugs are provided, and for manual movement the unit is mounted on a mild steel channel chassis fitted with rubber-tyred wheels and a guide bar. Weight of the unit is 10 cwt.

Two types of gas-fired portable mould dryers are shown, one being the now well-known "Newstad" unit with forced draught "Vortex" burner and safety valves to give protection against either gas or electrical failure. The other is the Axialiet-M dryer, designed by engineers of the North Western Gas Board and manufactured by the company under licence. In addition, there is an oil-fired portable mould dryer, self-contained, with its own oil tank holding sufficient oil for 10 hr. continuous drying.

Monometer Manufacturing Company Ltd.—This company is providing a reception lounge in which visitors can see a pictorial display of murals and photographs of the many types of melting furnace installations for which the company has been responsible. These include rotary tilting furnaces and rotary furnaces for the production of malleable irons, high duty iron alloys, and for the melting of steel. Also for copper, gunmetals and all non-ferrous metals, for the bulk melting of aluminium and for the refining of lead battery plates and residues. The latest design heated hot metal receivers with lifting roof as installed at the New Thames Foundry of the Ford Motor Company. Then there are semi-rotary melting furnaces for bronzes, gunmetals and aluminium foundries; crucible melting furnaces for all non-ferrous metals, hydraulic lip-axis tilting, central axis tilting, bale-out and lift-out types; new design reverberatory continuous melting, holding and bale-out furnace for aluminium die-casting foundries; valve-outlet and bale-out furnaces for lead and white metals, and whitemetal bearing pressure casting plant.

Morgan Crucible Company Ltd.—Two crucible furnaces are being shown on this stand. They are the Birlec Morgan Electric Die-casting Furnace Mark II and the oil-fired Morgan Basin Tilter. The former, developed only a year ago, is being shown in an improved Mark II version. Simplification of the cover, the electrical equipment and the control panel, has enabled Morgans to make a considerable price reduction; this is combined with a greatly improved performance. Briefly, the furnace can handle a throughput at 720°C. of approximately 125 lb. of aluminium per hr.

The oil-fired Basin Tilter as a bulk melter gives simple, comfortable operation, all the advantages of lip pouring and a high melting rate. This furnace is the most up-to-date unit so far produced for feeding maintaining furnaces in the die foundry. It has a 380 lb. or 500 lb. aluminium capacity, depending on the crucible used, and can bring down a 380 lb. charge in 30 min. or 500 lb. in 40 min. But the Basin Tilter is not only the best possible stablemate for the E.D.F. It is also suitable for copper-base alloys. It can melt ½ ton of brass in 1 hr., or ¾ ton in 80 min. Similar charges of gunmetal take only 10 min. more in each case. For all applications, the spouted basin shaped crucible facilitates the charging of ingot or bulky scrap, and the built-in tilting mechanism gives a simple finger-tip control of pouring, resulting in a steady stream which enables ladles and carrying crucible to be kept in one position throughout the pour.

J. V. Murcott Limited.—Established in 1929, this company has made a name for itself in the world of die-casting. Among the pressure die-castings which are displayed on their stand are instrument cases and flow meters for George Kent Ltd.; and John Thompson Instrument Co. Ltd.; electric drill bodies for Wolf Electric Tools Ltd.; brake drums for the Enfield Cycle Co. Ltd.; and electric fence mechanism cowls for Wolseley Engineering Ltd.

A battery of pressure die-casting machines has recently been added to by the acquisition of a Triulzi 25M machine from Italy, and only recently an entirely new process was devised by the company, covering the formation of large cavities of precise dimensions within the body of a pressure die-cast component.

Newton Collins Ltd. — Representative of their general activities in dust and fume removal this company is displaying one of their fettling benches with a unit collector. This bench has been developed primarily, as the name implies, to suit the fettling operations in iron and steel foundries, but there are other obvious applications, such as the cutting of stone and refractory blocks, where it is equally efficient. The function of the bench is to control the light air-borne dust and ensure clean air in the breathing zone of the operator.

The Owen Organization.—The various units of this group of companies are making an interesting display of their products. Rubery Owen and Co. Ltd. are emphasizing the Hallsworth automatic moulding machine. Mechanair, are showing one working model which will provide the compressed air for the moulding machine, and one static model T.S.16 compressor.

C. and L. Hill Ltd., are showing samples of Hill Chill phosphor bronze bars, cored, round and solid. Hill Alzen (Sales) Ltd., hold exclusive rights to manufacture and market Alzen 305 in ingot form in the U.K. with a non-exclusive licence for castings and fabricated parts. T. S. Harrison and Sons Ltd. are showing two grinding machines, widely used in the foundry trade. They are model G.20, a double unit high-speed machine for heavy duty purposes, and the model G.14, a smaller double-ended general purpose grinder.

Peco Machinery Sales (Westminster) Ltd.—Pressure die-casting machines are featured on this exhibit and for the first time, one of the latest series of three machines is on view at this exhibition. The 40DC5 model, with a locking force of 300 tons will be found casting in aluminium on the stand. This machine is a medium size in the new series. Others range up to the 60DC20 machine with a locking force of 750 tons, casting up to 26 lb. aluminium or 85 lb. brass.

Two output features are emphasized:— (1) recirculation—this device prevents cavitation in the injection circuit and ensures that when the die is fully packed, there is an instantaneous changeover from high-speed injection to high-pressure squeeze —consolidating the casting and eliminating porosity. (2) adjustable locking stroke—the stroke on all machines can be adjusted to eliminate all excess movement, reducing cycle time to the minimum. Die height is adjusted within very wide limits by a central screw.

Platt Metals Ltd.—From this company comes typical examples of non-ferrous metal ingots as supplied to the U.K. and overseas. The examples include whitemetal, zinc alloy, brass, phosphor bronze, aluminium bronze, lead bronze, gunmetal, printing metal and refined lead. We believe this company is the only maker of non-ferrous ingots showing at this exhibition.

Pneulec Limited.—Two entirely new machines are being demonstrated for the first time here. The S.J. Five shockless jolt squeeze is a large heavy duty machine taking boxes up to 4 ft. by 2 ft. 6 in. with 10 in. strip. This machine has a patented method of impacting, which eliminates the use of a coil spring and the awkward necessity of optimum loading. Simple means are provided for regulating frequency and intensity of impact and the bump is always crisp and in tune. When full out, the degree of intensity of impact with the mould against the squeeze head is phenomenal. This can be regulated at will down to a gentle tapping.

The other machine is the BLO-Shooter, a dual purpose machine which will blow or shoot cores and moulds as required. This machine will shoot any sand which can be rammed by hand, including clay bonded and sticky oilsand. No agitation of the sand in the magazine is necessary. The model demonstrated is a type 40, which blows a core 40 lb. nett weight.

Prat-Daniel (Stroud) Ltd.—A range of clean air equipment for foundries includes a model of an installation incorporating a specially-designed dust and spark arrester, circulating pipework, return troughing and settling tank. Then there are tubular dust collectors, of which a sectional model is shown. For the smaller dust-collecting applications, the company displays a cyclonic unit which embodies the principles of wet collection with that of high efficiency cyclonic separation.

Premo Pattern Co. Ltd.—This Birmingham company is exhibiting metal and resin plastics pattern equipment, both single-sided and double-sided plates.

Production Chemicals (Rochdale) Ltd.—The principal exhibit here is "Olivine Sand" of Norwegian origin, for which the company is general agent in the U.K. This material is stated to represent a new development in foundry technique contributing to high quality and finish, particularly for manganese steel and high-alloy steel castings. On show are castings made with this sand.

As a result of research and development, improvements in the quality of the firm's Bentonites have made them very suitable for foundry sands. The Sulphite Lye—liquid and spray dried powder—exhibited have a usage in the foundry industry in admixture with other core bonding materials.

Rapid Magnetic Machines Ltd.—A number of specialist products are being shown by this Birmingham company. A new totally enclosed overband separator, for the extraction of sprigs, headers, risers, chills, chaplets, etc., from foundry sands is exhibited in application form over a conveyor. A reminder of the company's wide range of permanent magnetic equipment is in the form of their Magnaplates—for suspending over conveyors or fixed to sand-slinging equipment for protection of impeller blades from damage. A new portable foundry separator, of particular use to the small jobbing foundry, is available for inspection and test. A heavy duty lifting magnet is also shown.

E. A. Roper and Co. Ltd.—Among the items shown by this company are the following:— geared ladle hoists with a range of ladles for use with same, also one of their standard range of geared crane ladles incorporating up-to-date features of modern ladle practice. There is also a model of Roper water-cooled type spark arrester, a sectional cupola model demonstrating internal and external water-cooling zone, as well as a display of large photographs illustrating the latest features of the company's cupola charging systems.

F. E. Rowland and Co. Ltd.—On this stand will be seen an extensive range of foundry machines such as grinding machines, etc.

Shell Chemical Company Ltd.—This stand is devoted to illustrating the use of "Epikote" epoxy resins in the manufacture of loose patterns, pattern plates and core boxes. These resins are said to be finding increasing application in the foundry industry. "Epikote" resin patterns are stated to be light in weight, with high dimensional stability, good abrasion resistance, do not rust and give excellent release from moulding sand. Information is also available on the stand on resin systems suitable for the production of heat resistant core boxes and ultra-lightweight laminated patterns.

H. G. Sommerfield Ltd.—On this London firm's stand can be seen a heavy duty centrifugal shot thrower serving a 10 ft. dia. rotary table. The thrower, being fitted with a primary impellor and adjustable feed cage, imparts a consistent and powerful impact and is operated by a 15 h.p. motor. In the heavy duty compressed air section, there are photographs of some of the more important installations recently executed by the company. Shotblast ancillary equipment and supplies, including abrasives are displayed also.

Spencer and Halstead Ltd.—The exhibits here include blast cleaning machines of both airless and compressed air operated types selected from a full range of equipment available to the trade. Machines on show are an airless cabinet; a 36 in. by 42 in. airless rotary barrel; a 7 ft. 6 in. dia. rotary table machine and a 6 ft. general purpose airless blast cleaning room.

Other exhibits include the smallest of a series of fully automatic blast cleaning machines designed to enable blast cleaning to be incorporated in flow production; pressurized blast cleaning plant together with a selection of dust and fume exhaust equipment and the firm's latest wet type dust arrester. A series of photographs describe examples of large blast cleaning plants and foundry dust exhaust equipment.

Sterling Foundry Specialities Ltd.—A number of examples illustrating the very wide range of sizes and styles of the Sterling rolled steel moulding boxes, are being displayed on this stand. In recent years this range has been increased to include the largest size up to approximately 14 ft. wide and 30 ft. long, and a box 3 ft. wide by 12 ft. long is also shown.

The firm is also showing three Sterling high-speed shakeout machines; pattern plates in various materials; the new Perm Alum squeeze-in bottom board recently developed in the U.S.A., and a pair of aluminium slip flasks with the alternative of steel or aluminium jackets to suit.

Sternol Limited.—This company is exhibiting examples and pictorial illustrations of core assemblies bonded with their various types of "Sternocore," "Sternobind" and "Corkol" products.

Tilghman's Limited.—Among the machines exhibited by this Cheshire house is a 7 ft^3 capacity Autoblast, one of a range of machines designed to augment the Tumblast range, and incorporating a number of features including a new high capacity wheel which throws more than twice the abrasive and is easier to service, greater separator efficiency, close-fitting flights in cleaning chamber, new door seal preventing abrasive loss, and Blast-Lyfe wear parts throughout. This machine is operating on a demonstration cycle with a completely automatic sequence of operations. It is exhausted by a new design, model 96TH54, dust collector. This is one of a new range of collectors designed for low headroom sites.

Also exhibited is a new design 9 ft. dia. rotary table (plain type), one of a range in which the main features are pitless construction, reduced headroom, new design elevator, new compact wheel unit, variable speed table drive, and built-in control panels. In addition, there is a rotary barrel shotblast machine, a well proven design modified to incorporate a new method of automatic loading.

Union Carbide Limited, Alloys Division.—From this company comes a display of many of the ferroalloys and metals which it supplies to the iron, steel and non-ferrous foundries, together with a special display of technical data on rarer metals and their compounds. Silicon metal, electrolytic manganese and chromium, calcium-manganese-silicon, and nickel-boron, are the main items of interest to non-ferrous foundries.

West Midlands Gas Board.—Fuel technologists are available here to deal with enquiries in relation to the use of gas in foundries and industrial fuels in general. A series of exhibits and photographs illustrate the part gas plays in the industrial field.

Wright and Platt Ltd.—This company is exhibiting a selection of wood and metal first-class pattern equipment. Photographs are also shown of some of the unusually large patterns which the company has made, together with patterns for shell moulding, epoxy resin patterns, gravity dies and pressure cast plates.

Industrial News *Home and Overseas*

Canning Scholarships

It was announced at the annual general meeting of **W. Canning and Company Ltd.**, last week, that the company are to endow two scholarships, one in chemistry and the other in industrial metallurgy, at Birmingham University, in the name of **Sir Ernest Canning**, who retired from the chairmanship of the company recently and has now been appointed President of the company.

The value of each scholarship will be £750 a year, and they will be known as the "Sir Ernest Canning Scholarships," to perpetuate the association of his name with the sciences to which his business life was so closely connected.

New Laboratories

In connection with the opening of the new laboratories of the **British Non-Ferrous Metals Research Association** on Wednesday of last week, the Association gave a luncheon at the Savoy Hotel, London, at which Dr. Maurice Cook, C.B.E., chairman of the Council of the Association, presided. He was supported at the top table by Sir Alexander Fleck, K.B.E., F.R.S., chairman of Imperial Chemical Industries Ltd.; His Excellency the Hon. George Drew, Q.C., High Commissioner for Canada; His Excellency the Rt. Hon. Sir Eric Harrison, K.C.V.O., High Commissioner for Australia; His Excellency Sir Gilbert Rennie, G.B.E., K.C.M.G., M.C., High Commissioner for the Federation of Rhodesia and Nyasaland, and other notable personalities from science and industry and the Government.

Following the Loyal Toast, proposed by the chairman, the toast of "The British Non-Ferrous Metals Research Association" was proposed by Sir Alexander Fleck and replied to by Dr. Maurice Cook, who also proposed the toast of "The Guests." Response to this was made by His Excellency the Hon. George Drew.

Previous to the luncheon, Sir Alexander Fleck had unveiled a plaque at the headquarters of the association commemorating the opening of the new laboratories that morning. In his speech at the luncheon, Sir Alexander said that it was especially appropriate that the plaque should be made of titanium, because it emphasized the growing interest which the Association must undoubtedly take in what are sometimes called the "newer" metals—interest which he saw was already reflected by the inclusion of studies on uranium, thorium, titanium and zirconium in the research programme of the Association.

Lead from Australia

Australian lead exports were now expected to gain in other directions, despite the United States restrictions, the Minister for National Development, Senator W. H. Spooner, said in the Senate last week. "The extent to which it is now expected that Australian lead exports will be reduced is less than the market we have lost in the United States," Senator Spooner told a questioner.

Senator Spooner said it had been estimated that Australia would export a total of 207,500 tons of lead in 1959. But, following the imposition of the U.S. restriction, and the reductions agreed to recently at a world conference of lead production nations, the revised estimate for this year had been reduced to 178,200 tons. This meant that the total drop for 1959 was 29,300 tons. The U.S. restrictions cut Australian exports by 33,000 tons —from 75,000 to 42,000. Therefore, Australia would gain by 3,700 tons in exports to markets outside the United States. "This leads to the conclusion that we anticipate gains in other directions," he added, "despite the restrictions."

CO_2 Process

A new product for use in the CO_2 process has recently been made available by **Colloidal Graphite Limited,** of Sheffield. This product, known as "Moldgraph," is a dispersion of finely graded graphite suitable for application to mould or die surfaces. The dispersion is in a fast-drying non-aqueous medium, so that application may be made direct to silicate treated surfaces such as are prepared in the CO_2 process. The concentration of solid graphite content is sufficient to ensure an excellent coating with one application.

It is stated by the company that this product is quite stable under ordinary conditions of storage, and slight sedimentation under storage can be rectified by shaking or stirring. We also understand that the material is inflammable and should, therefore, be stored with care.

Coloured Aluminium

Some of the leading figures in Birmingham's architectural and building circles, together with representatives of anodizing and other processing firms, took part in a discussion on "Weather-Resistant Colour-Anodized Finishes" at the Midland Hotel, Birmingham, last week. They also saw an exhibition of coloured sheet, sections and components in the full range of available colours. This event was arranged by the **Aluminium Development Association,** whose member companies include a number of important wrought and cast aluminium fabricators in and around Birmingham.

The exhibition may be seen in the entrance hall of the College of Arts and Crafts, Margaret Street, Birmingham, and will be on public view for the next two weeks. It shows examples of colour anodized aluminium made up into curtain wall panels; and demonstration pieces showing different combinations and including cladding systems, spandrels and windows. There are also panels showing the full range of available colours both on plain aluminium and on aluminium coated with aluminium-silicon alloy.

Aluminium in Building

A Symposium on Aluminium in Building has been arranged by the **Aluminium Development Association** for Thursday and Friday, July 9 and 10, 1959. It will be held at the Royal Institute of British Architects, 66 Portland Place, W.1, by courtesy of the President and Council of the Institute. Some fourteen Papers will be introduced, reporting in detail the advances made—some of them very recent and significant to future trends. There will be three sessions for discussion: (i) Aluminium as a building material; (ii) Aluminium curtain walling; (iii) Aluminium building applications.

The principal objects of the Symposium are to provide a forum for the free exchange of views between architects and builders on the one hand, and the aluminium industry on the other; to receive suggestions and criticisms which will help to develop further new items by the aluminium industry and manufacturers, and to indicate future possibilities for extending the usefulness of aluminium in this important field of application.

A Birmingham Exhibit

At the Engineering Centre, Birmingham, **Imperial Chemical Industries Ltd.** have recently provided a new layout of exhibits and photographs featuring its wide range of products in copper, brass, aluminium, titanium and zirconium. Other items of interest are wrought titanium, aluminium profiled sheets for roof and wall cladding, and aluminium lorry body sections. The display also includes specimens of fuel cans in aluminium, magnesium, and zirconium alloys.

Scottish News

It is understood that the Royal Ordnance Factory at Bishopton in Renfrew is to be extended and an additional 300 workers employed. This follows the closing of the R.O.F. at Irvine and concentration of the work on Bishopton.

Meanwhile, Irvine Town Council is seeking to develop engineering toolmaking and allied industry in the town to absorb the men dismissed from the Ordnance plant. Already they have been successful in securing a good reaction, particularly from Scandinavian manufacturers.

Birfield Group Foundries

An announcement from the board of **Birfield Industries Limited** is to the effect that action is being taken in accordance with plans to rationalize the group's foundry interests. These plans will mean that special plant and equipment of the Phosphor Bronze Company Ltd. in Birmingham will be transferred to other locations within the group.

At the headquarters of the group in London, a Birfield spokesman said that the new move will not mean any break in the continuity of work on existing contracts, and customers are being advised of detailed arrangements for their future requirements as soon as possible

Malayan Tin

Singapore tin shipments in the first half of May totalled $6\frac{1}{4}$ tons, compared with $9\frac{3}{4}$ in the first half of April and $503\frac{1}{2}$ in the first half of May last year, according to Straits Trading Company figures issued. Of the first half May shipment, India took six tons and the Middle East a quarter of a ton. Penang shipments in the first half of this month totalled $2,210\frac{3}{4}$ tons, against $1,058\frac{1}{2}$ in the first half of April, and $1,026\frac{3}{4}$ tons in the corresponding period last year. Of this month's shipments so far, the U.S. received 1,325 tons, Europe 30, Canada 75, Japan $367\frac{1}{4}$,

the Pacific area $3\frac{1}{2}$, India $211\frac{3}{4}$, South America $75\frac{3}{4}$, and Australasia 122 tons.

Golf Meeting

On Thursday of last week, the **National Association of Non-Ferrous Metal Merchants' Golfing Society** held its Spring meeting at the Berkshire Golf Club. The morning round was a bogey Stableford competition for the President's prize, which was won by Mr. H. T. Viney. The runner-up was Mr. G. Litherland and Mr. F. Aston was third.

In the afternoon a Greensome against bogey was played, the winners being Mr. J. E. Lisle and Mr. J. Wolff, with Mr. R. Easdale and Mr. G. Holloway as runners-up.

At the annual general meeting of the society, held on the previous evening, the officers elected for the ensuing year were as follows:—President, Mr. R. O. Barnett; captain, Mr. H. Shields; treasurer, Mr. L. E. Ricketts; and secretary, Mr. G. B. Garnham.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses dropped by 295 tons and were distributed as follows at the end of last week: London 5,036 tons, Liverpool 2,152 tons, and Hull 1,039 tons.

Stocks of refined copper rose by 350 tons and were as follows:—London 2,022 tons, Liverpool 4,194 tons, Birmingham 775 tons, Manchester 3,800 tons, and Hull 475 tons.

An Open Day

News from the **Fulmer Research Institute** at Stoke Poges is that it proposes to hold an Open Day (by invitation only) on July 16 this year. A cross-section of the work in progress will be exhibited and two new laboratories will be open for inspection.

A Removal

It is announced by **The Reddish Chemical Company Ltd.** that they are now located at Globe Works, Stanley Road, Cheadle Hulme, nr. Stockport. The telephone number is Hulme Hall 4406.

Aluminium Production

In anticipation of an average increase in business over 1958, Aluminium Company of America has programmed 1959 pig aluminium production at about 624,000 tons—or some 20 per cent more than last year's output — President Mr. Frank L. Magee said recently. This total includes output from the two potlines started up this week, which moved Alcoa's operating rate up to 82 per cent of its 798,250 tons per year installed capacity. "At this point, however, there are too many variables in the present business situation to permit accurate forecasting as to whether this programme can be maintained or perhaps exceeded," Mr. Magee added in a speech before the New York Society of Security Analysts.

Mr. Magee explained that Alcoa would be operating some other currently idle potlines, "with a corresponding increase in profits," if it were not obliged to take quantities of metal from Canada under contracts drawn up in the Korean War emergency. Excluding deliveries to the U.S. Government stockpile—an avenue for sales that ended for Alcoa in 1958—the Company's sales last year totalled 269,500 tons in the first half and 305,800 tons in the second half. "Present bookings indicate that second quarter shipments will also show substantial improvement," Mr. Magee said. No projects in the original 600,000,000 dollar expansion programme which Alcoa announced three years ago, have been eliminated or reduced, although some completion dates have been extended and other projects have been added, Mr. Magee stated. With capital outlays of about 65,000,000 dollars in 1959, for a total of 530,000,000 dollars, this programme will be slightly better than 88 per cent completed by the year end, he added.

A Birmingham Meeting

On Friday next, May 29, the annual meeting of the **Birmingham Metallurgical Society** will be held at 6 p.m. at the Birmingham Engineering Centre, Stephenson Place, Birmingham.

Welding News

Erection of the 200 ton capacity Goliath crane at Bradwell nuclear power station has been simplified by the prefabrication of certain sections by automatic welding. Half of the components of the crane were fabricated by automatic welding equipment supplied by **Quasi-Arc Limited,** using a Fusarc self-propelled welding machine with Seamec electrodes.

The crane, which weighs in the region of 800 tons, is 177 ft. high, and on test has lifted loads of more than 250 tons. It has enabled installation of heavy boiler and reactor structures to proceed, while still allowing civil engineering work on the reactor buildings to go on unhindered.

Lead and Zinc Cutbacks

Speaking in Ottawa on Tuesday last, Mr. Gordon Churchill, Canadian Trade Minister, said that voluntary reductions in export of lead and zinc by several countries, including Canada, might be a first step to solving the problem of world surpluses.

Reporting to the Commons on the 20-nation lead and zinc conference, under United Nations auspices, which ended recently, Mr. Churchill said Canada informed the other nations that Canadian producers planned to curtail production and thus reduce exports by 9,000 tons of lead and 30,000 tons of zinc in 1959.

Mr. Churchill said this and similar action by other producer countries should cut the expected world zinc surpluses to 16,000 tons from the 120,000 tons forecast earlier in the year. The outlook for the lead metal surplus "is not quite so satisfactory," he said. He tabled the report of the New York conference, which indicated that the anticipated surplus of this metal would be cut to 104,500 tons through production cutbacks of 45,500 tons.

Broken Hill Production

It is reported from Melbourne, Australia, that the Directors of North Broken Hill Limited and Broken Hill South Limited have announced that they would not cut production further at their Broken Hill mines. The directors said it was not intended to reduce production at the company's mine as a result of the recently concluded agreement on lead and zinc at the United Nations. Under the agreement reached at the United Nations, sales of lead metal derived from the company's concentrates during the six months to end December this year would be approximately 1,000 tons less than the estimated sales for the current half year to June 30, the directors added.

The company expected to sell substantially the whole output of zinc concentrates. It would finance excess production of lead concentrates and metal in the belief that it was in its best interests to do so. Budgeted ore production to the end of this year conformed approximately to the agreed levels.

New Appointments

Two new appointments have been made in the Meter, Relay and Instrument Division of **The English Electric Company Ltd.,** Stafford. Mr. G. E. Robertson, A.M.I.E.E., has been appointed manager, sales and contracts, of the division, and Mr. P. G. Bevis has been appointed manager, sales and contracts, of the relay department.

Wiggin News

In the latest issue of *Wiggin Nickel Alloys*, an article features the use of nickel in the manufacture of a tank for the transportation of phenol by road. Corrosion threatens both the life of the carrying equipment and the purity of the product. The article shows how "AT" nickel is used to protect the purity, and, therefore, the colour, of phenol.

Also featured in this issue is the use of steel plates clad with nickel or Monel in the construction of heavy items of chemical plant. Other articles include the uses of nickel-containing materials in fast passenger launches, high-speed steam cleaning units, and a review of high-temperature brazing techniques. The magazine is obtainable from **Henry Wiggin and Company Ltd.**

G.E.C. Sales Areas

To establish a closer relationship with its customers and to cope with the growth of its business, **The General Electric Company Ltd.** has established a new sales and distribution area office at Magnet House, Hanger Lane, Ealing, London, W.5, which will cover the North London, Eastern and Southern Counties area, including the existing G.E.C. branches at Ipswich, Dagenham, Luton, Reading, Southampton and Bournemouth.

This is the first stage in a major plan to decentralize what has, up to now, been the London sales area. The next stage will be the establishment of a new area office in South London which will cover the territory south and south-east of Central London. The Central London area office is to be established in Magnet House, Kingsway, W.C.2.

Obituary

Mr. H. W. Greenwood

It is with much regret that we record the death, after a short illness, of Mr. H. W. Greenwood, formerly with Powder Metallurgy Limited. He was one of the original members of the Institute of Metals, and spent many years in the mining industry in Spain. It was in 1939 that he joined Powder Metallurgy Limited, and for some years organized the commercial side of the business. Latterly, his activities were mainly in the direction of writing articles on powder metallurgy for the technical press. He continued working vigorously up to the time of his recent illness at the age of 77.

Metal Market News

LAST week saw the publication of the Copper Institute statistics for last month, which are shown as follows, in short tons of 2,000 lb. Inside the United States, the output of crude or blister copper was 112,468 tons, or about 5,000 tons less than the March total of 117,530 tons. In refined copper, the output was 137,490 tons, against 140,928 tons a month earlier. Deliveries of refined copper to consumers, however, showed an advance from 124,220 tons to 135,233 tons, while stocks of refined copper were understandably lower, the total at April 30 being 74,323 tons, compared with 82,952 tons at the end of March. Outside the United States production of crude copper was virtually unchanged, being only 710 tons below the March figure at 169,027 tons. Output of refined metal was also down, the total last month, at 141,469 tons, comparing with 144,497 tons in March. Deliveries to users showed a fairly sharp drop of some 11,500 tons to 135,029 tons, while stocks in producers' hands rose by fully 19,000 tons to 255,548 tons at the end of April. On balance, it will be noted that stocks rose by barely 11,000 tons, which is, of course, of no great significance. However, the trend is very much as anticipated, for consumers are stocking up in the United States and tending to reduce their holding in Europe. Indeed, there are good grounds for believing that there has been a certain amount of reselling by users. Consumption in the United States is certainly very good, and may well remain so, but it is reasonable to assume that some stocking up is going on.

Virtually nothing has leaked out about the discussions which have taken place between producers and consumers on the subject of an alternative price as a basis for sales of copper. It is generally understood that a scheme was submitted recently by the producers to some of their customers but, according to report, this was unacceptable to the users. Now it would seem that the consumers are going to give the whole subject consideration, but just how long their deliberations are likely to take is a matter for conjecture. In view of the complexity of the problem and the fact that users in several countries are involved, several months may well elapse before anything tangible emerges. In the opinion of some people, however, nothing will come of these talks, so that it is possible we shall not hear anything official about this matter. On the other hand there are grounds for believing that the producers concerned with this new venture are very keen on the creation and adoption of an alternative quotation, and that being so we may expect that the idea will not lightly be abandoned. In the meanwhile, business on the non-ferrous front is rather quiet although, as will be seen from the details given of trading on the Exchange, the turnovers, especially in lead, were reasonably good, and all prices rather higher on balance.

Business in metal futures came to an end after the midday session on Friday and was not resumed until last Tuesday. The strength of Wall Street was of general help to sentiment, but there were no special features. In standard copper, the week opened with news of a further advance of 175 tons in L.M.E. stocks to 10,916 tons, but nevertheless the tone was fairly steady. In all, from Monday to Friday midday, the turnover was 8,075 tons, and at the close cash was £3 15s. 0d. up at £234 15s. 0d., while three months showed an advance of £3 5s. 0d. at £236. The contango was reduced to £1 5s. 0d. Stocks of tin increased by 7 tons to 8,522 tons. Trading amounted to 785 tons, and both positions gained £1 at £784 10s. 0d. and £785 cash and forward. Lead was active with a turnover of 13,850 tons, the close being £71 15s. 0d. and £72 7s. 6d. Values advanced by £1 and 10s. In zinc, 6,725 tons changed hands, the close being £78 5s. 0d. May and £76 10s. 0d. August. Prompt was up 30s. and forward 25s.

New York

On the Commodity Exchange, copper was steady after earlier easiness. Lead and zinc were steady. In physical copper, custom smelters reported good demand for their 32 cents copper, but their available supply was light because of meagre scrap copper offerings. Dealers, however, reported negligible consumer interest at their levels around 32¾. A leading trader source said June copper was very tight, but consumers will not pay more than 32 cents for copper. Producers reported little change in their situation. Tin was quiet and steady. Lead and zinc sales were moderate. The American Smelting Company said that the Tacoma plant was open to receive men reporting back to work, but informed sources said that so far not enough have returned to put the plant back into operation.

The Bureau of Mines, Department of the Interior, has announced that it is renewing its investigation of bauxite deposits in Hawaii, and will conduct extensive testing of specimens to see if an economic method can be developed for extracting alumina. Two Bureau representatives have been despatched to Hawaii and will direct the collection of representative samples from the Island of Kauai, site of the most extensive bauxite deposits, according to Bureau Director, Mr. Marling J. Ankeny. Plans call for collecting a total of eight samples, each weighing about 200 lb. These will be sent to the Bureau's laboratories at Rolla, Mo., where they will undergo metallurgical treatment by Federal specialists in bauxite benefication. The project stems from a co-operative agreement with the territory of Hawaii, which approved funds to finance the study. It follows preliminary co-operative work undertaken a year ago on Hawaiian bauxite by the Bureau of Mines in which the Bureau reported that additional research was justified "in view of the apparent immensity" of the deposits.

The same relatively low rate of demand continued for platinum during the past week and the market in the U.S. did not seem to be improved. Leading refiners still adhered to their officially published asking rates of 77 dollars per troy ounce in bulk, and 80 dollars in lesser quantities. Outside market dealers were able to offer metal as low as 73 dollars per ounce, and in some instances a dollar cheaper.

Senator James E. Murray, Chairman of the Senate Interior Committee, said last week that he had been advised by the head of the Office of Civil and Defense Mobilization that the Federal Government had no plan to dump stockpile copper on the market.

Birmingham

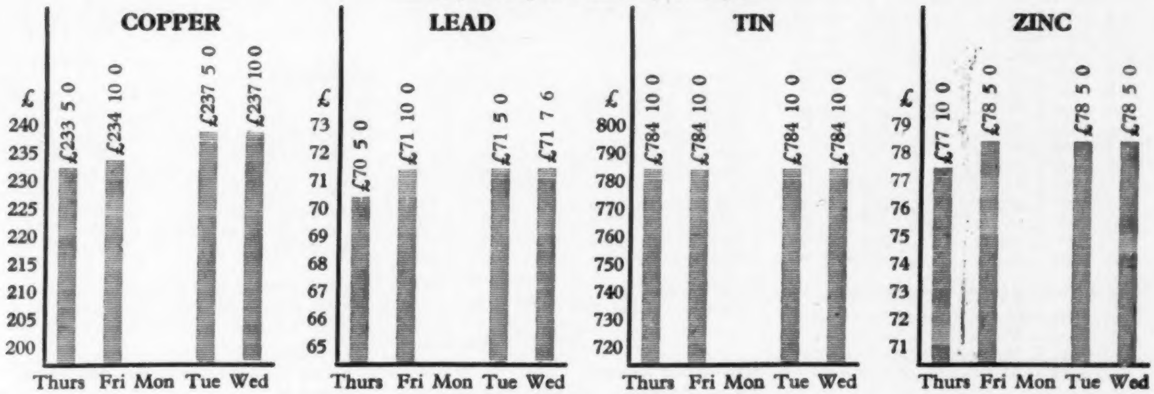
Business has been quiet in the Midland industrial area this week following the Whitsuntide holiday, when the works were closed for a long weekend. The tone of trade generally, however, is brighter, and there is a confident feeling amongst manufacturers. The requirements of the motor trade as far as non-ferrous metals are concerned are large. The expected increase in business in commercial vehicles has not yet materialized, despite the tax relief in the Budget. Building trade needs are moderate, but makers of domestic fittings are feeling the effect of increasing competition from the plastics trade. Works rolling sheet and strip are equipped for a bigger output than they are making at present.

The expansion of demand in the iron and steel industry continues. With stocks gradually declining, consumers are coming into the market again for a variety of products, especially sheets and strip. The motor trade is one of the biggest buyers of sheets and iron castings. There is a fair demand for heavy plates for tank and boiler making. Makers of railway rolling stock have added some important contracts to their books since the beginning of the year. Mills producing steel tubes have more work, and more shifts are being worked than at the beginning of the year.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 14 May to Wednesday 20 May 1959



Primary Metals

All prices quoted are those available at 2 p.m. 20/5/59

		£	s.	d.
Aluminium Ingots....	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%..	„	190	0	0
Antimony Oxide......	„	180	0	0
Antimony Sulphide Lump............	„	190	0	0
Antimony Sulphide Black Powder........	„	205	0	0
Arsenic..............	„	400	0	0
Bismuth 99·95%......	lb.		16	0
Cadmium 99·9%	„		9	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		14	0
Columbite.... per unit			—	
Copper H.C. Electro..	ton	237	10	0
Fire Refined 99·70%	„	236	0	0
Fire Refined 99·50%	„	235	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	9	6¾
Indium	„		10	0
Iridium.............	„	24	0	0
Lanthanum	grm.		15	0
Lead English..........	ton	71	7	6
Magnesium Ingots....	lb.		2	3
Notched Bar	„		2	9½
Powder Grade 4......	„		6	1
Alloy Ingot, A8 or AZ91	„		2	4
Manganese Metal....	ton	245	0	0
Mercury	flask	77	10	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	

		£	s.	d.
Palladium	oz.	7	5	0
Platinum	„	28	10	0
Rhodium	„	41	0	0
Ruthenium	„	18	0	0
Selenium	lb.		nom.	
Silicon 98%..........	ton		nom.	
Silver Spot Bars......	oz.		6	7¼
Tellurium	lb.		15	0
Tin.................	ton	784	10	0
***Zinc**				
Electrolytic..........	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	77	2	6
Dust 95/97%........	„	109	0	0
Dust 98/99%........	„	115	0	0
Granulated 99+% ..	„	102	2	6
Granulated 99·99+%	„	116	2	6

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg	≏£/ton	Canada c/lb	≏£/ton	France fr/kg	≏£/ton	Italy lire/kg	≏£/ton	Switzerland fr/kg	≏£/ton	United States c/lb	≏£/ton
Aluminium			22.50	185 17 6	224	163 0	375	221 5	2.50	212 10	26.80	214 10
Antimony 99.0					220	165 0	445	262 10			29.00	232 0
Cadmium					1,350	1,012 10					130.00	1,040 0
Copper												
Crude												
Wire bars 99.9							460	271 10 0				
Electrolytic	32.50	239 5 0	30.50	252 0	327	245 5			2.90	246 12 6	31.50	252 0
Lead			10.25	84 12 6	104	78 0	167	98 17 6	.85	74 0	12.00	96 0
Magnesium												
Nickel			70.00	578 5	900	675 0	1,200	708 0	7.50	637 10	74.00	592 0
Tin	111.25	817 2 6			1,126	844 12 6	1,500	885 0	9.60	816 0	103.00	824 0
Zinc												
Prime western			11.25	92 17 6							11.00	88 0
High grade 99.95			11.85	94 0 0								
High grade 99.99			12.25	101 2 6								
Thermic					114.00	85 12 6						
Electrolytic					122.00	91 12 6	170	100 7 6	.95	80 17 6	12.25	98 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 20/5/59

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10	„	221	0	0
B.S. 1490 L.M.11	„	215	0	0
B.S. 1490 L.M.12	„	223	0	0
B.S. 1490 L.M.13	„	216	0	0
B.S. 1490 L.M.14	„	224	0	0
B.S. 1490 L.M.15	„	210	0	0
B.S. 1490 L.M.16	„	206	0	0
B.S. 1490 L.M.18	„	203	0	0
B.S. 1490 L.M.22	„	210	0	0

†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	—		
B.S. 1490 L.M.2	„	—		
B.S. 1490 L.M.4	„	—		
B.S. 1490 L.M.6	„	—		

*Aluminium Bronze				
BSS 1400 AB.1......	ton	—		
BSS 1400 AB.2......	„	—		

		£	s.	d.
***Brass**				
BSS 1400-B3 65/35 ..	ton	155	0	0
BSS 249	„	—		
BSS 1400-B6 85/15 ..	„	196	0	0
***Gunmetal**				
R.C.H. 3/4% ton	„	—		
(85/5/5/5)	„	193	0	0
(86/7/5/2)	„	204	0	0
(88/10/2/1)	„	242	0	0
(88/10/2/½)	„	256	0	0
***Manganese Bronze**				
BSS 1400 HTB1....	„	192	0	0
BSS 1400 HTB2....	„	207	10	0
BSS 1400 HTB3....	„	215	0	0
Nickel Silver				
Casting Quality 12%	„	220	0	0
„ „ 16%	„	230	0	0
„ „ 18%	„	240	0	0
***Phosphor Bronze**				
B.S.1400 P.B.1.(A.I.D. released)	„	286	0	0
B.S. 1400 L.P.B.1	„	213	0	0

**Average prices for the last week-end.*

		£	s.	d.
Phosphor Copper				
10%	ton	253	0	0
15%	„	255	10	0
Phosphor Tin				
5%	„	—		
Silicon Bronze				
BSS 1400-SB1	„	247	0	0
Solder, soft, BSS 219				
Grade C Tinmans....	„	365	10	0
Grade D Plumbers..	„	294	5	0
Grade M	„	401	0	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.	—		
Type 9 „	„	—		
Zinc Alloys				
Mazak III	ton	109	7	6
Mazak V	„	113	7	6
Kayem	„	119	7	6
Kayem II	„	125	7	6
Sodium-Zinc	lb.		2	6½

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

		£	s.	d.
Aluminium				
Sheet 10 S.W.G.	lb.		2	8½
Sheet 18 S.W.G.	„		2	10½
Sheet 24 S.W.G.	„		3	1½
Strip 10 S.W.G.	„		2	8½
Strip 18 S.W.G.	„		2	9½
Strip 24 S.W.G.	„		2	11
Circles 22 S.W.G.	„		3	2½
Circles 18 S.W.G.	„		3	1½
Circles 12 S.W.G.	„		3	0½
Plate as rolled	„		2	8
Sections	„		3	2
Wire 10 S.W.G.	„		2	11½
Tubes 1 in. o.d. 16 S.W.G.	„		4	1
Aluminium Alloys				
BS1470. HS10W.				
Sheet 10 S.W.G.	„		3	1
Sheet 18 S.W.G.	„		3	3½
Sheet 24 S.W.G.	„		3	11
Strip 10 S.W.G.	„		3	1
Strip 18 S.W.G.	„		3	2½
Strip 24 S.W.G.	„		3	10½
BS1477. HP30M.				
Plate as rolled......	„		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	„		3	9½
Sheet 18 S.W.G.	„		4	2
Sheet 24 S.W.G.	„		5	0½
Strip 10 S.W.G.	„		3	10½
Strip 18 S.W.G.	„		4	2
Strip 24 S.W.G.	„		4	9½
BS1477. HPC15WP.				
Plate heat treated..	„		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		5	0½
BS1476. HE10WP.				
Sections	„		3	1½
Brass				
Tubes..............	„		1	10½
Brazed Tubes........	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	252	5	0
Extruded Bar........	lb.		2	0½
Extruded Bar (Pure Metal Basis)	„		—	

		£	s.	d.
Brass				
Condenser Plate (Yellow Metal)	ton	187	0	0
Condenser Plate (Naval Brass)	„	199	0	0
Wire	lb.		2	7⅞
Beryllium Copper				
Strip	„	1	4	11
Rod................	„	1	1	6
Wire	„	1	4	9
Copper				
Tubes	lb.		2	3½
Sheet	ton	265	10	0
Strip	„	265	10	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	286	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	6¾

		£	s.	d.
Lead				
Pipes (London)	ton	111	5	0
Sheet (London)	„	109	0	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7% ..	lb.		3	8
Wire 10%	„		4	2¾
Phosphor Bronze				
Wire	„		4	1

Titanium (1,000 lb. lots)			
Billet over 4″ dia.-18″ dia.	lb.	63/-	64/-
Rod 4″ dia.-·250″ dia.	„	75/-	112/-
Wire under ·250″ dia.-·036″ dia.	„	146/-	222/-
Sheet 8′ × 2′ × ·250″-·010″		88/-	157/-
Strip ·048″-·003″......	„	100/-	350/-
Tube................	„		300/-
Extrusions	„		120/-

Zinc		£	s.	d.
Sheet	ton	113	5	0
Strip	„	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 19/5/59.

	£
Aluminium	
New Cuttings	146
Old Rolled	126
Segregated Turnings	98
Brass	
Cuttings	155
Rod Ends	145
Heavy Yellow	125
Light	120
Rolled	148
Collected Scrap	123
Turnings	138
Copper	
Wire	216
Firebox, cut up	213
Heavy	210
Light	205
Cuttings	216
Turnings	196
Braziery	164

	£
Gunmetal	
Gear Wheels	184
Admiralty..................	184
Commercial................	166
Turnings	159
Lead	
Scrap	62
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	166
Turnings	159
Zinc	
Remelted	68
Cuttings	54
Old Zinc	38

Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of Mar., 1959, have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follows in long tons:—

COPPER	Gross Weight	Copper Content
Wire	17,673	17,316
Rods, bars and sections	12,480	8,264
Sheet, strips and plate	12,208	9,544
Tubes	6,632	6,124
Castings and miscellaneous	6,576	—
Sulphate	3,167	—
	58,736	47,431

Of which:	
Consumption of Virgin Copper	36,124
Consumption of Copper and Alloy Scrap (Copper Content)	11,307

LEAD	
Cables	7,642
Batteries	2,577
Battery Oxides	2,313
Tetra Ethyl Lead	1,717
Other Oxides and Compounds	1,880
White Lead	544
Shot	313
Sheet and Pipe	4,867
Foil and Collapsible Tubes	323
Other Rolled and Extruded	496
Solder	1,165
Alloys	1,743
Miscellaneous Uses	1,111
Total	26,691

TIN	
Tinplate	892
Tinning:	
Copper Wire	40
Steel Wire	8
All other	67
Solder	182
Alloys	445
Foil and Collapsible Tubes, etc.	42
Tin Compounds, Salts, and Miscellaneous Uses	97
Total Consumption	1,773

ZINC	
Galvanizing	8,129
Brass	8,356
Rolled Zinc	1,884
Zinc Oxide	2,535
Zinc Die-casting alloy	4,436
Zinc Dust	1,025
Miscellaneous Uses	878
Total, All Trades	27,243
Of which:	
High purity 99·99 per cent	4,673
Electrolytic and high grade 99·95 per cent	5,175
Prime Western, G.O.B. and debased	10,273
Remelted	457
Scrap Brass and other Cu alloys	3,559
Scrap Zinc, alloys and residues	2,879

ANTIMONY	
Batteries	91
Other Antimonial Lead	44
Bearings	25
Oxides—for White Pigments	103
Oxides—other	59
Miscellaneous Uses	16
Sulphides	5
Total Consumption	343

Antimony in Scrap	
For Antimonial Lead	425
For Other Uses	71
Total Consumption	496

CADMIUM	
Plating Anodes	38·55
Plating Salts	6·20
Alloys: Cadmium Copper	5·35
Alloys: Other	3·15
Batteries: Alkaline	7·90
Batteries: Dry	0·45
Solder	0·80
Colours	17·10
Miscellaneous Uses	0·95
Total Consumption	80·45

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£205.17.6)	235
Heavy copper	(£201.10.0)	230
Light copper	(£175.5.0)	200
Heavy brass	(£118.5.0)	135
Light brass	(£92.0.0)	105
Soft lead scrap	(£57.0.0)	65
Zinc scrap	(£36.15.0)	42
Used aluminium unsorted	(£83.5.0)	95
France (francs per kilo):		
Electrolytic copper scrap	(£191.5.0)	255
Heavy copper	(£191.5.0)	255
No. 1 copper wire	(£180.0.0)	240
Light brass	(£112.12.6)	150
Zinc castings	(£48.15.0)	65
Lead	(£64.12.6)	86
Aluminium	(£120.0.0)	160

Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead, soft, first quality	(£75.12.6)	128
Lead, battery plates	(£41.17.6)	71
Copper, first grade	(£215.10.0)	365
Copper, second grade	(£203.2.6)	345
Bronze, first quality machinery	(£200.15.0)	340
Bronze, commercial gunmetal	(£171.2.6)	290
Brass, heavy	(£138.15.0)	235
Brass, light	(£123.17.6)	210
Brass, bar turnings	(£127.0.0)	215
New zinc sheet clippings	(£51.5.0)	97
Old zinc	(£42.10.0)	72

Financial News

Coley Metals

Dividend 15 per cent (20 per cent) year to January 31, 1959. Group net profit £34,158 (£39,186), after tax £37,843 (£63,741). From fixed assets replacement reserve £20,000 (nil). To general reserve £100,000 (nil).

Amalgamated Metal

Final dividend 6 per cent, making 9 per cent for 1958 (same). Group profit £405,160 (£432,903) after tax of £412,502 (£590,472). Attributable to company £437,109 (£430,109).

Goodlass Wall

Group profits rose from £3,036,000 to £3,452,000, and net profit from £1,472,000 to £1,739,000. Holding company's profit is £1,018,000 (£919,000) after minority interests £89,000 (£63,000) and retained by subsidiaries £632,000 (£490,000). A dividend of 16 per cent is recommended.

Head Wrightson and Co.

Group trading profit on completed work increased to £1,815,173 (£1,735,422). After depreciation £229,118 (£199,433), pensions provision £80,000 (nil), and tax £636,011 (£835,574) the balance is up to £874,654 from £722,574. Dividend of 15 per cent recommended.

Metal Products (Willenhall)

Final dividend 7½ per cent, making 15 per cent year to March 31, 1959 (same). Net profit £38,490 (£29,191), after tax of £38,826 (£40,251). To general reserve £15,000 (£20,000), forward £45,143 (£45,564).

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Metal Products (Arden) Ltd. (626621), Dalehouse Lane, Kenilworth. Registered April 24, 1959. To carry on business of general engineers and machinists, specialists in fabricating metal work, etc. Nominal capital, £3,000 in 2s. 6d. shares. Directors: Richard Hunter, Harold Fielding and Sydney W. Stanley.

Precision Dies and Tools Limited (626697), 4 Church Green East, Redditch. Registered April 24, 1959. Nominal capital, £2,000 in £1 shares. Directors: Eric G. D. Giles, Mrs. Janet E. Giles, Clifford J. Chester and Mrs. Joan E. Chester.

F. Higgins Limited (626725), 47 Brass Street, Birmingham. Registered April 24, 1959. To carry on the business of metal polishing, etc. Nominal capital, £100 in £1 shares. Directors: Frederick Higgins and Mrs. Jessie Higgins.

F. H. Booth Limited (626733), Yorkshire House, Chapel Street, Liverpool. Registered April 27, 1959. To carry on the business of iron, steel or other metal manufacturers and merchants, etc. Nominal capital, £1,000 in £1 shares. Directors: Francis H. Booth, Philip S. Taylor and Mrs. Mary Booth.

THE STOCK EXCHANGE

Industrials Continued To Show All Round Firmness And Activity Maintained

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 19 MAY +RISE—FALL		DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	27/3	+6d.	9	10	6 12 0	27/3	23/3	24/9	17/6
400,000	2/-	Anti-Attrition Metal	1/3		4	8¼	6 8 0	1/6	1/3	1/9	1/3
41,305,038	Stk. (£1)	Associated Electrical Industries ...	60/6		15	15	4 19 3	61/9	54/-	58/9	46/6
1,609,032	1	Birfield	50/6	+1/9	15	15	5 18 9	59/-	47/-	62/4½	46/3
3,196,667	1	Birmid Industries	76/-	+3d.	17½	17½	4 12 0	76/10½	72/-	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	43/6		11	10	5 1 3	43/6	36/1½	39/-	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/6	—9d.	5	5	6 9 0	16/3	15/-	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9		6	6	6 15 3	18/1½	17/9	17/4½	16/6
500,000	1	Bolton (Thos.) & Sons	30/-		10	10	6 13 3	30/-	27/6	28/9	24/-
300,000	1	Ditto Pref. 5%	15/6		5	5	6 9 0	15/6	15/-	16/-	15/-
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/-		7	7	7 0 0	—	—	20/4½	19/-
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	19/6		6	6	6 3 0	19/7½	18/9	20/-	18/4½
15,000,000	Stk. (£1)	British Insulated Callender's Cables	55/6		12½	12½	4 10 0	56/-	47/6	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	59/9	+1/9	10	10	3 7 0	59/9	49/3	52/-	28/3
1,200,000	Stk. (5/-)	Canning (W.) & Co.	15/9xcap	—3d.	25 + *2½C	25	3 19 3	32/-	15/9	25/3	19/3
60,484	1/-	Carr (Chas.)	2/7½	+6d.	12½	25	4 15 3	2/7½	1/3	2/3	1/4½
150,000	2/-	Case (Alfred) & Co. Ltd.	5/6	+3d.	25	25	9 1 9	5/6	4/7½	5/3	4/-
555,000	1	Clifford (Chas.) Ltd.	23/6		10	10	8 10 3	23/6	22/6	22/-	16/-
45,000	1	Ditto Cum. Pref. 6%	16/-		6	6	7 10 0	16/-	15/3	16/-	15/-
250,000	2/-	Coley Metals	3/9	—3d.	20	25	10 13 3	4/-	2/10½	4/6	2/6
8,730,596	1	Cons. Zinc Corp.†	60/6	—1/6	18⅜	22½	6 4 0	67/6	60/-	65/3	41/-
1,509,528	1	Davy & United	103/9		20	15	3 17 0	106/3	86/-	87/-	45/9
5,830,000	5/-	Delta Metal	16/6xcap	+1½d.	31‡	30	4 13 9	33/7½	16/4½	25/-	17/7½
4,600,000	Stk. (£1)	Enfield Rolling Mills Ltd.	50/6	+1/6	15	12½	5 18 9	50/6	36/7½	38/-	22/9
750,000	1	Evered & Co.	31/6		10 §	15 Z	6 7 0	31/6	30/-	30/-	26/
18,000,000	Stk. (£1)	General Electric Co.	32/-	—6d.	10P	12½		40/3	30/9	40/6	29/6
1,500,000	Stk. (10/-)	General Refractories Ltd.	34/-		20	20	5 17 9	40/-	32/6	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	65/-		16½	15	5 1 6	66/6	64/-	67/6	61/-
750,000	5/-	Glacier Metal Co. Ltd.	7/3		11¼	11¼	7 18 6	7/3	6/7½	8/3	5/-
1,750,000	5/-	Glynwed Tubes	18/9	—3d.	20	20	5 6 9	19/3	16/4½	18/1½	12/10½
5,421,049	10/-	Goodlass Wall & Lead Industries ...	38/6	+3/-	13‖	18Z	3 7 6	38/6	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	84/-		20	17½	4 15 3	84/-	75/-	57/9	45/-
396,000	5/-	Harrison (B'ham) Ord.	19/-		*17½	*15	4 12 0	19/-	14/11¼	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	—	—	19/9	18/4½
1,075,167	5/-	Heenan Group	8/1½		10	10‡	6 3 0	8/6	7/6	9/7½	6/9
236,958,260	Stk. (£1)	Imperial Chemical Industries ...	34/3	—3d.	12Z	10	4 13 3	38/3	33/9	38/-	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	16/9	—3d.	5	5	5 19 6	17/1½	16/-	17/1½	16/-
14,584,025	**	International Nickel	165½	+1½	$2.60	$3.75	2 16 3	171	153	169	132⅜
860,000	5/-	Jenks (E. P.), Ltd.	10/9	+3d.	14	27½ɸ	6 9 3	10/9	8/9	10/-	6/7½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3		5	5	6 3 0	16/3	15/4½	16/9	15/-
3,987,435	1	Ditto Ord.	59/6	+4/-	10	10	3 7 3	59/6	44/3	47/-	36/6
600,000	10/-	Keith, Blackman	28/9		17½E	15	6 1 9	28/9	25/-	28/9	15/-
320,000	4/-	London Aluminium	5/9		10	10	6 19 3	6/4½	5/3	6/-	3/-
765,012	1	McKechnie Brothers Ord.	42/6		15	15	7 1 3	45/-	42/6	45/-	32/-
1,530,024	1	Ditto A Ord.	39/6		15	15	7 12 0	43/6	39/6	45/-	30/-
1,108,268	5/-	Manganese Bronze & Brass	16/3		20⅝	20	6 8 3	16/3	13/9	14/1½	8/9
50,628	6/-	Ditto (7½% N.C. Pref.)	6/-		7½	7½	7 10 0	—	—	6/3	5/6
13,098,855	Stk (£1)	Metal Box	79/-	+1/-	11	11	2 15 9	79/-	66/6	73/3	40/6
415,760	Stk. (2/-)	Metal Traders	9/9		50	50	10 5 3	9/9	8/4½	9/-	6/3
160,000	1	Mint (The) Birmingham	25/-		10	10	8 0 0	25/-	22/-	22/9	19/-
80,000	5	Ditto Pref. 6%	72/6		6	6	8 5 6	75/6	69/-	83/6	69/-
3,705,670	Stk. (£1)	Morgan Crucible A	46/6		10	10	4 6 0	46/6	43/6	45/-	34/-
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6		5½	5½	6 5 9	18/6	17/6	18/-	17/-
2,200,000	Stk. (£1)	Murex	46/-		17½	20	7 12 3	50/-	42/-	58/9	46/-
468,000	5/-	Ratcliffs (Great Bridge)	9/9		10R	10	3 17 0	11/6	9/9	11/1½	6/10½
234,960	10/-	Sanderson Bros. & Newbould ...	31/6		20	27½D	6 7 0	31/6	27/9	27/3	24/6
1,365,000	Stk. (5/-)	Serck	20/4½	—6d.	15	17½	3 13 6	20/10½	18/-	18/7½	11/-
6,698,586	Stk. (£1)	Stone-Platt Industries	52/-	+3d.	15	12½	5 15 6	52/-	43/3	45/6	22/6
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	17/6		5½	5½	6 5 9	17/6	15/10½	16/3	12/7½
18,255,218	Stk. (£1)	Tube Investments Ord.	87/-	+1/6	17½	15	4 0 6	87/-	72/-	86/-	48/4½
41,000,000	Stk. (£1)	Vickers	33/9		10	10	5 18 6	37/-	30/6	36/3	28/9
750,000	Stk. (£1)	Ditto Pref. 5%	14/3		5	5	7 0 3	15/0¾	14/3	15/9	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/3	—3d.	*5	*5	7 5 0A	22/7½	21/-	23/-	21/3
2,200,000	1	Ward (Thos. W.), Ord.	90/6	+1/-	20	15	4 8 6	90/6	83/6	87/3	70/9
2,666,034	Stk. (£1)	Westinghouse Brake	43/6		10	10	4 12 0	47/-	39/9	46/6	32/6
225,000	2/-	Wolverhampton Die-Casting ...	9/7½	—3d.	30	25	6 4 9	10/6	8/8¼	10/1½	7/-
591,000	5/-	Wolverhampton Metal	26/-	—3d.	27½	27½	5 5 9	28/6	21/6	22/9	14/9
78,465	2/6	Wright, Bindley & Gell	6/6		20	20	7 13 9	6/7½	4/11¼	5/4½	2/9
124,140	1	Ditto Cum. Pref. 6%	13/9		6	6	8 14 6	13/9	13/6	13/-	11/3
150,000	1/-	Zinc Alloy Rust Proof	3/-		27	40D	9 0 0	3/1½	2/9	3/1½	2/7½

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. •The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ɸ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. P Interim dividend since reduced. § And Special distribution of 2½% free of tax. R And 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units.

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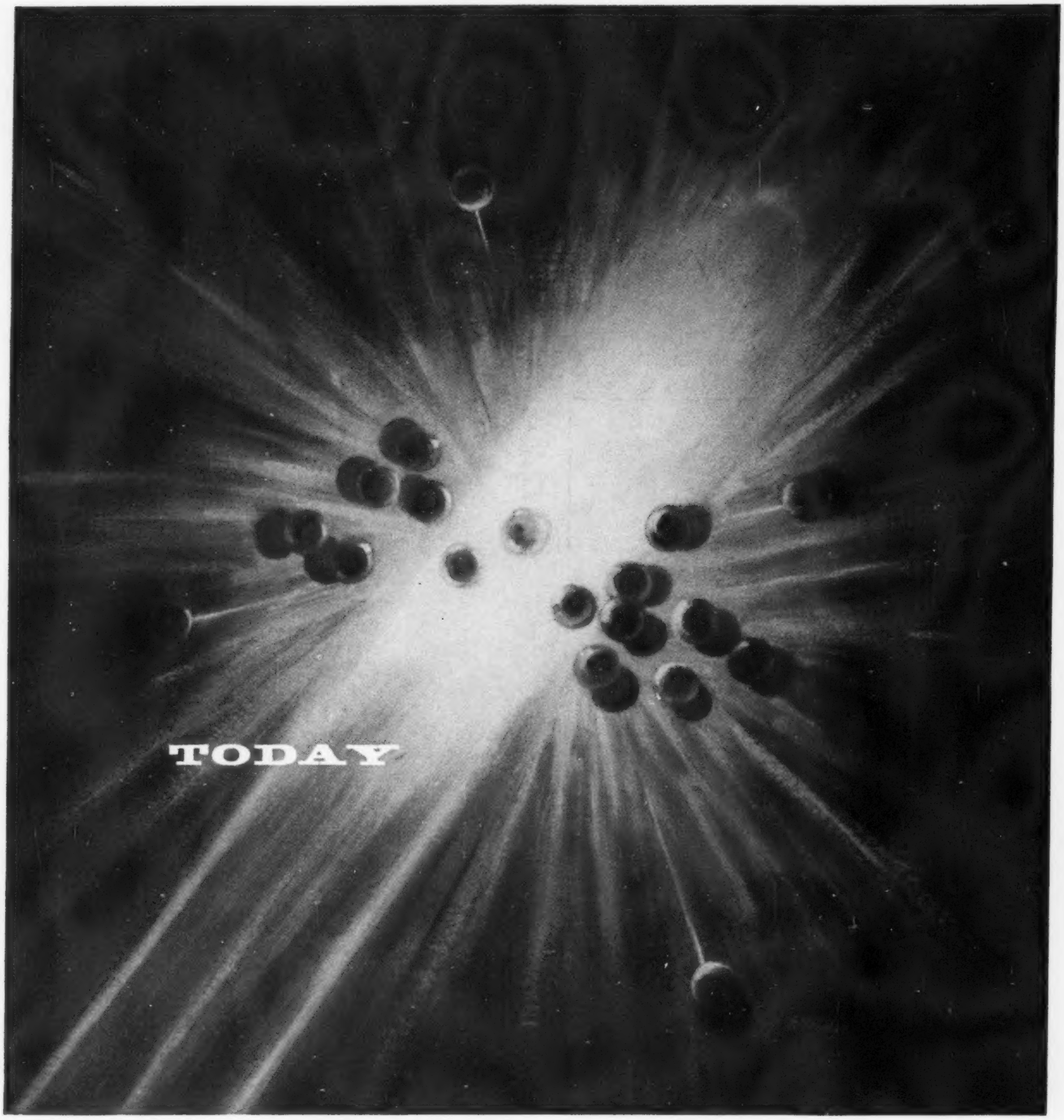
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